AGRICULTURAL ENGINEERING

JANUARY • 1955

In this Issue . . .

Steel "Squirrel" Speeds Ladder Operations and Cuts Fruit Production Costs

•

Engineers Develop Simple, Low-Cost Base Structure for Utility Farm Buildings

•

Tractor Engine Designed to Push Back the Horizon on High Compression

•

Correlating Engineering Design of Machines with Field and Laboratory Testing

•

Engineers Weigh Many-Sided Problem of Farm Buildings Animals Can Pay For

THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

...for the changing pattern of plowing

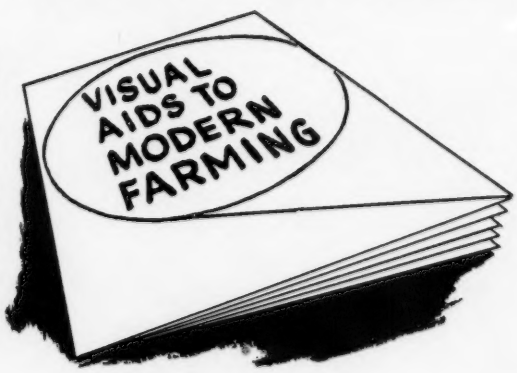
CASE PIVOT ACTION

This amazingly simple feature stands as an example of truly progressive and practical engineering research . . . functional design that gives contour farming a new impetus, a new kind of accuracy for greater conservation benefits. Yes, pivot action, built into the implement itself just at the right point, permits these plows to keep all bottoms cutting at full width on curves . . . without skidding or increasing draft.

Break-Away recouples by merely backing tractor

Like pivot action, the Case Break-Away Safety Release is another advance toward faster, more efficient plowing. Stumps and stones that would damage fixed plows merely cause the Case Mounted Plow to uncouple from its foreframe. Backing the tractor recouples it. A touch of the hydraulic control lifts it over the obstacle, and plowing proceeds.

- **For education, information** and training . . . the advantage of teaching visually everything from good plowing to pond building, strip cropping to water spreading and farm safety to seed saving . . . Case has clear, vivid materials. To see what may help you from sound-color movies to illustrated charts, send for the booklet that describes them all, "Visual Aids to Modern Farming." J. I. Case Co., Racine, Wis.



HOW TO TIGHTEN UP ON FARM PRODUCTION COSTS

Faced with the challenge of boosting farm profits, ag engineers are looking for new production tools to reduce operating costs. And among the most important tools on any farm are its buildings.

The answer to this need for low-cost, functional farm shelter is *steel buildings*. Modern farmers can't afford to spend the time needed to erect old-fashioned conventional structures. Steel buildings go up fast. Inexperienced farm hands can do the job quickly and easily with ordinary wrenches.

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To keep building maintenance at minimum, many manufacturers of steel farm buildings use Armco ZINCGRIP—a specially zinc-coated steel that gives long protection against rust. In 18 years of service, ZINCGRIP has proved itself as the dependable, low-upkeep steel for farm use.

If you are designing steel buildings or equipment, you can obtain further information on this special sheet steel by sending the coupon below.

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AGRICULTURAL ENGINEERING

Established 1920

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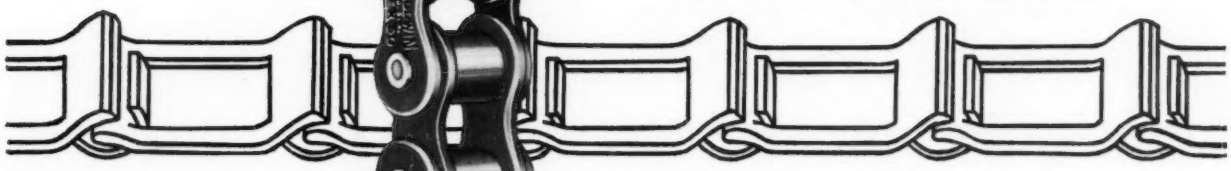

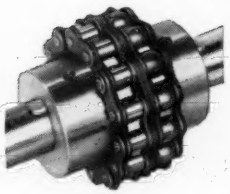

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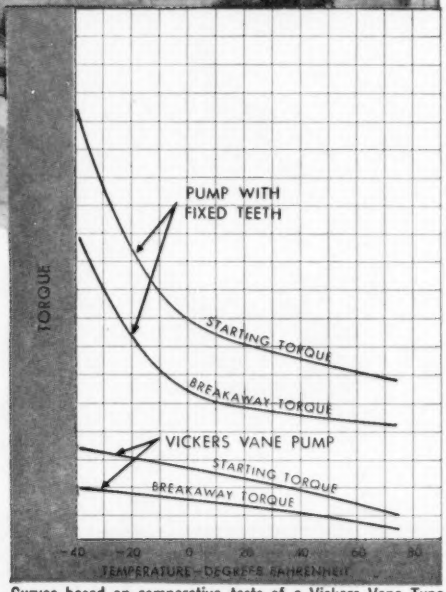
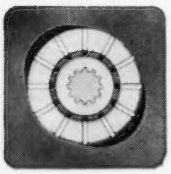
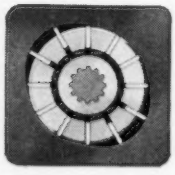


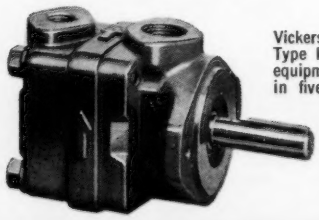
Curves based on comparative tests of a Vickers Vane Type Pump and an equal capacity pump with fixed teeth. Oil used in both was SAE 10W premium grade.





(Left) Schematic diagram of Vickers Balanced Vane Type Pump showing how sliding vanes are retracted at normal engine cranking speeds. No oil is pumped and there is practically no starting load.

(Right) Similar diagram of Vickers pump showing how pump vanes are extended when engine is running. Pumping then begins and continues at all engine speeds.



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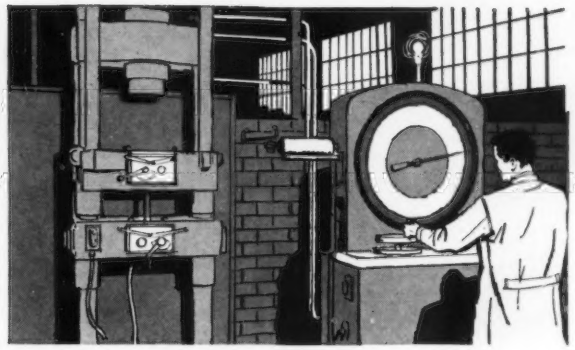

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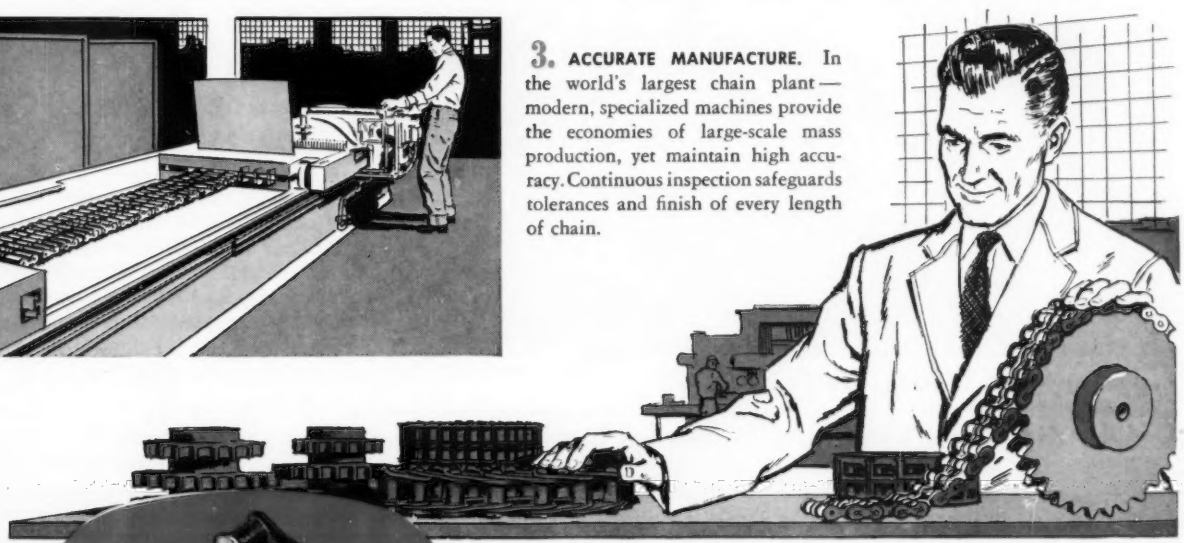

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						PLOWS (Bottoms)	CULTIVATORS (Rows)
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100	22.0	19.5	Transmission Driven	Touch-Control	4F, 1R	2-12"	1 wide 2-6 narrow
200	25.0	22.0	Transmission Driven	Touch-Control	4F, 1R	2-14"	2 wide 4-6 narrow
300	37.5	33.0	Completely Independent	Hydra-Touch	10F, 2R	3-14"	4 wide 4-6 narrow
400 (gas)	51.0	45.0	Completely Independent	Hydra-Touch	10F, 2R	4-14"	4 wide 4-6 narrow
400 (diesel)	48.3	43.9	Completely Independent	Hydra-Touch	10F, 2R	4-14"	4 wide 4-6 narrow

**Estimated maximum belt and drawbar horsepower, corrected to 60° F. and barometric pressure of 29.92 inches of mercury.*

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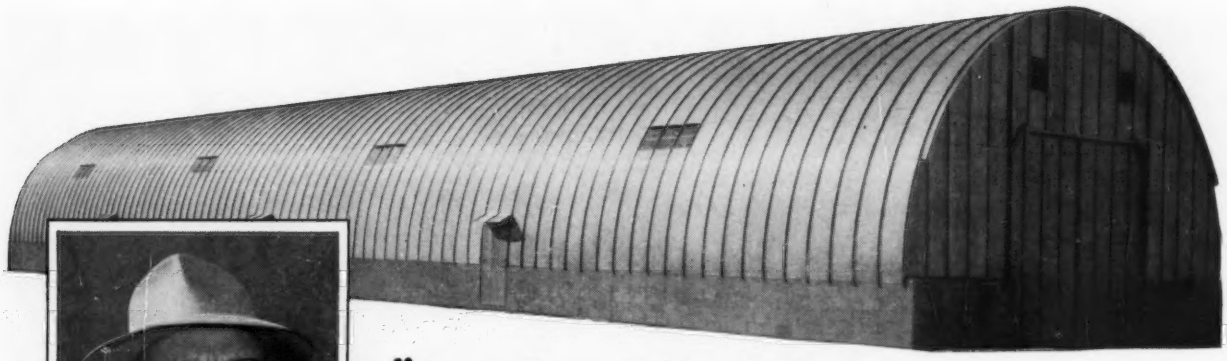

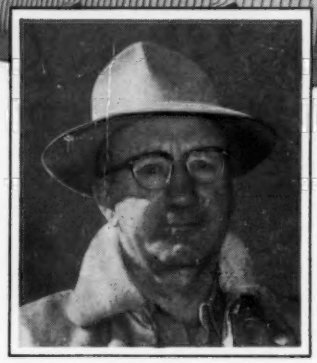

"Our Steel Building is one of our best investments"

says Harold Schoeman, Cedar Falls, Iowa

• In November of 1953, during a very dry season, Mr. Schoeman lost one of his large barns in a costly fire. "When our barn burned to the ground," says Mr. Schoeman, "we realized that a wooden structure is a handicap and very dangerous to other buildings in such a disaster. Having a large herd of purebred Guernseys to shelter, we immediately planned to replace the lost building."

After considering the low cost of steel and the low maintenance on it, Mr. Schoeman decided to buy and erect a 36' x 172' clear span utility type Steel building. The major part of the building houses his Guernseys and the remaining space is used for storing machinery, fertilizer and feed. "We are now convinced," Mr. Schoeman says, "that it is one of our best investments."

For dairy cattle housing, machinery and other storage, Steel buildings are ideal. They give maximum, unbroken floor area — allow the free movement of livestock or machinery with no posts to get in the way. Weather-tight Steel buildings are also excellent for hay and grain storage or as versatile all-purpose structures. You'll save on erection costs and upkeep when you invest in a Factory-Built Steel Farm Building manufactured with long-lasting USS Galvanized Steel Sheets for roof and walls, and a USS Structural Steel framework.

When buying a Factory-Built Steel Farm Building, ask for USS Galvanized Steel Sheets for roof and sides. These sheets have a zinc coating produced to ASTM Specification A-361. This is your assurance of a high quality building.

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Engine	Horsepower and Piston Displacement	Pounds per Horsepower	Fuel Consumption—pounds per BHP per hour	Horsepower per Cubic Inch Displacement	
Engine A	110 at 2200 RPM 358 cu. in.	(Stripped Engine) 7.38	.54	.307	**CHRYSLER ADVANTAGES OVER ENGINE A** . . . delivers 18 more horsepower . . . weighs 96 pounds less with 24% less weight per horsepower . . . uses 7.5% less fuel at average operating speed . . . delivers 26% more horsepower per cubic inch displacement
Chrysler Model Ind. 24A	128 at 2200 RPM 331 cu. in.	(Stripped Engine) 5.58	.50	.387	
Engine B	104 at 2400 RPM* 330 cu. in.	(Stripped Engine) 6.92	(Information not available)	.315	**CHRYSLER ADVANTAGES OVER ENGINE B** . . . delivers 34 more horsepower . . . weighs 5 pounds less with 25% less weight per horsepower . . . delivers 32% more horsepower per cubic inch displacement
Chrysler Model Ind. 24A	138 at 2400 RPM 331 cu. in.	(Stripped Engine) 5.18	.50	.416	
Engine C	99 at 2200 RPM 320 cu. in.	(Stripped Engine) 7.64	.56	.309	**CHRYSLER ADVANTAGES OVER ENGINE C** . . . delivers 29 more horsepower . . . weighs 60 pounds less with 27% less weight per horsepower . . . uses 10.5% less fuel at average operating speed . . . delivers 25% more horsepower per cubic inch displacement
Chrysler Model Ind. 24A	128 at 2200 RPM 331 cu. in.	(Stripped Engine) 5.58	.50	.387	
Engine D	117 at 2200 RPM 317 cu. in.	6.5**	.50	.369	**CHRYSLER ADVANTAGES OVER ENGINE D** . . . delivers 11 more horsepower . . . weighs 19 pounds more *but* with 6% less weight per horsepower . . . delivers 5% more horsepower per cubic inch displacement
Chrysler Model Ind. 24A	128 at 2200 RPM 331 cu. in.	6.1**	.50	.387	
Engine E	97 at 2200 RPM 372 cu. in.	(Complete Engine) 12.85	.58	.260	**CHRYSLER ADVANTAGES OVER ENGINE E** . . . delivers 31 more horsepower . . . weighs 395 pounds less with 48.7% less weight per horsepower . . . uses 14% less fuel at average operating speed . . . delivers 49% more horsepower per cubic inch displacement
Chrysler Model Ind. 24A	128 at 2200 RPM 331 cu. in.	(Complete Engine) 6.6	.50	.387	

**Information not available at 2200 RPM **Complete engine less flywheel housing*

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- low unit cost
- long service life
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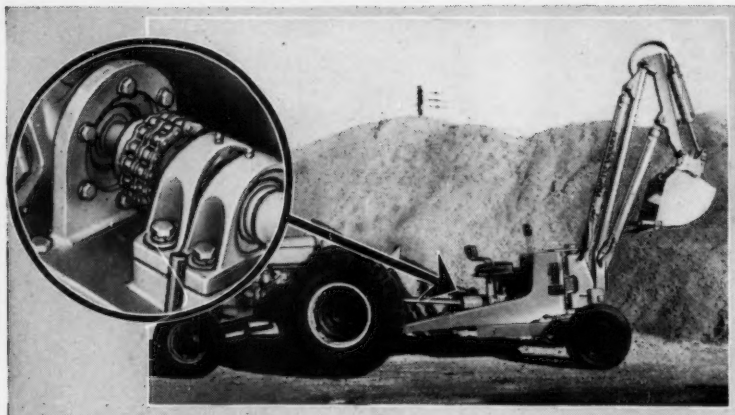
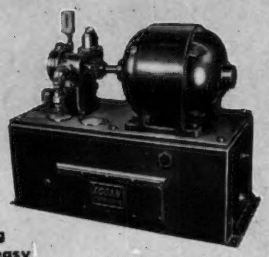
- runs directly on hardened shafts
- permits use of larger and stiffer shafts

SOLVE YOUR SHAFT CONNECTION PROBLEMS WITH DIAMOND FLEXIBLE COUPLINGS!



POWER TAKE-OFF

Diamond Flexible Coupling connects drive shaft from tractor to hydraulic pump on trailer type back-hoe.

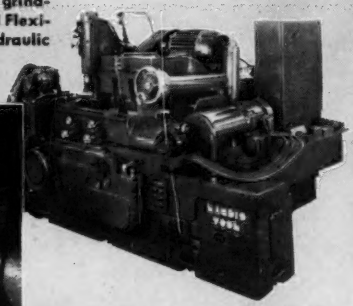


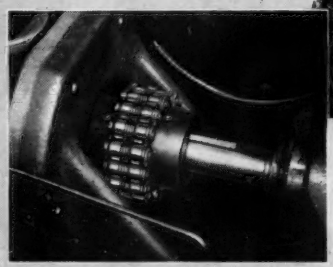
HYDRAULIC PUMP DRIVE

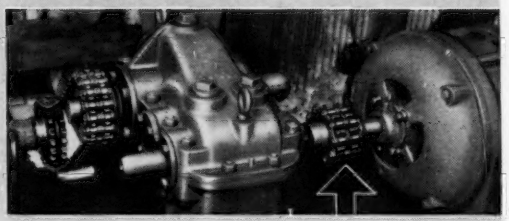
Diamond Coupling provides quick, easy installation. Driving and driven shafts need not be of the same diameter.

MACHINE TOOL APPLICATION

This modern multiple wheel hydraulic grinding machine uses a compact Diamond Flexible Coupling between motor and hydraulic pump.







ELECTRIC MOTOR TO SPEED REDUCER

High speed shaft connections require little space with compact Diamond Couplings. Installation is quick and easy.

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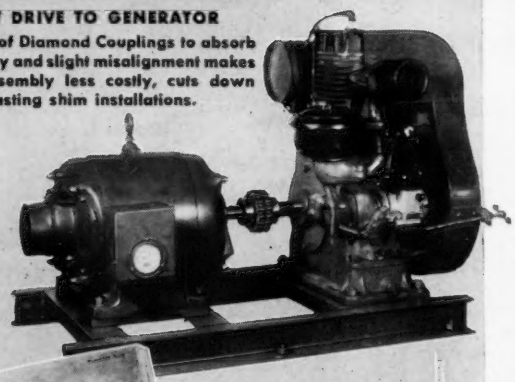
Ability of Diamond Couplings to absorb end-play and slight misalignment makes unit assembly less costly, cuts down time-wasting shim installations.



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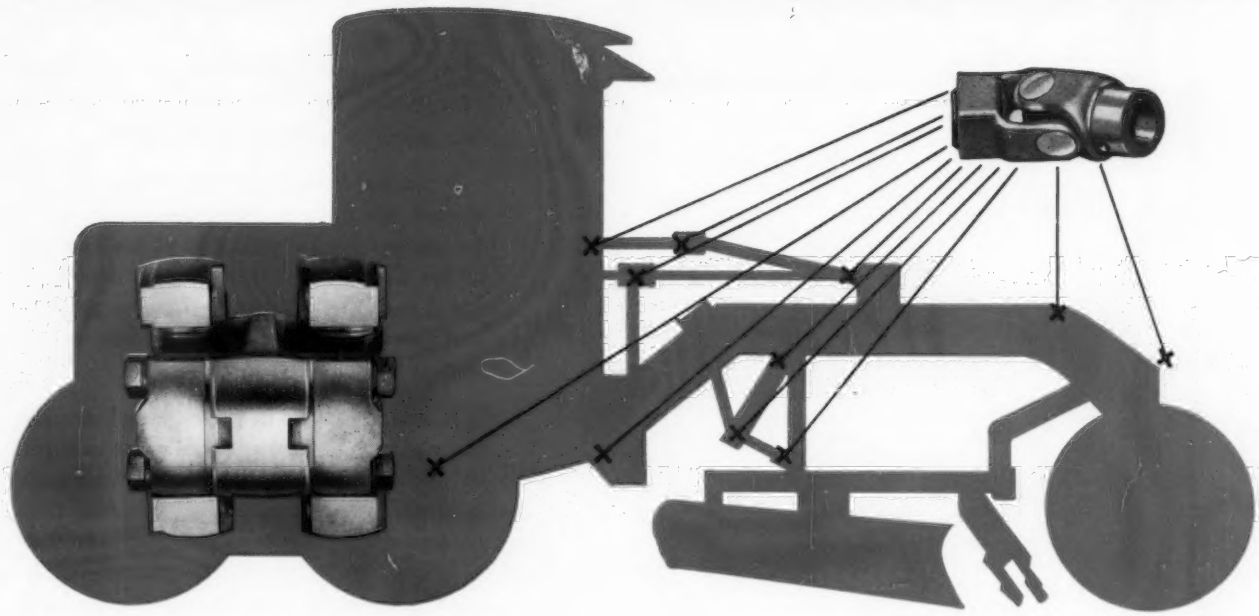

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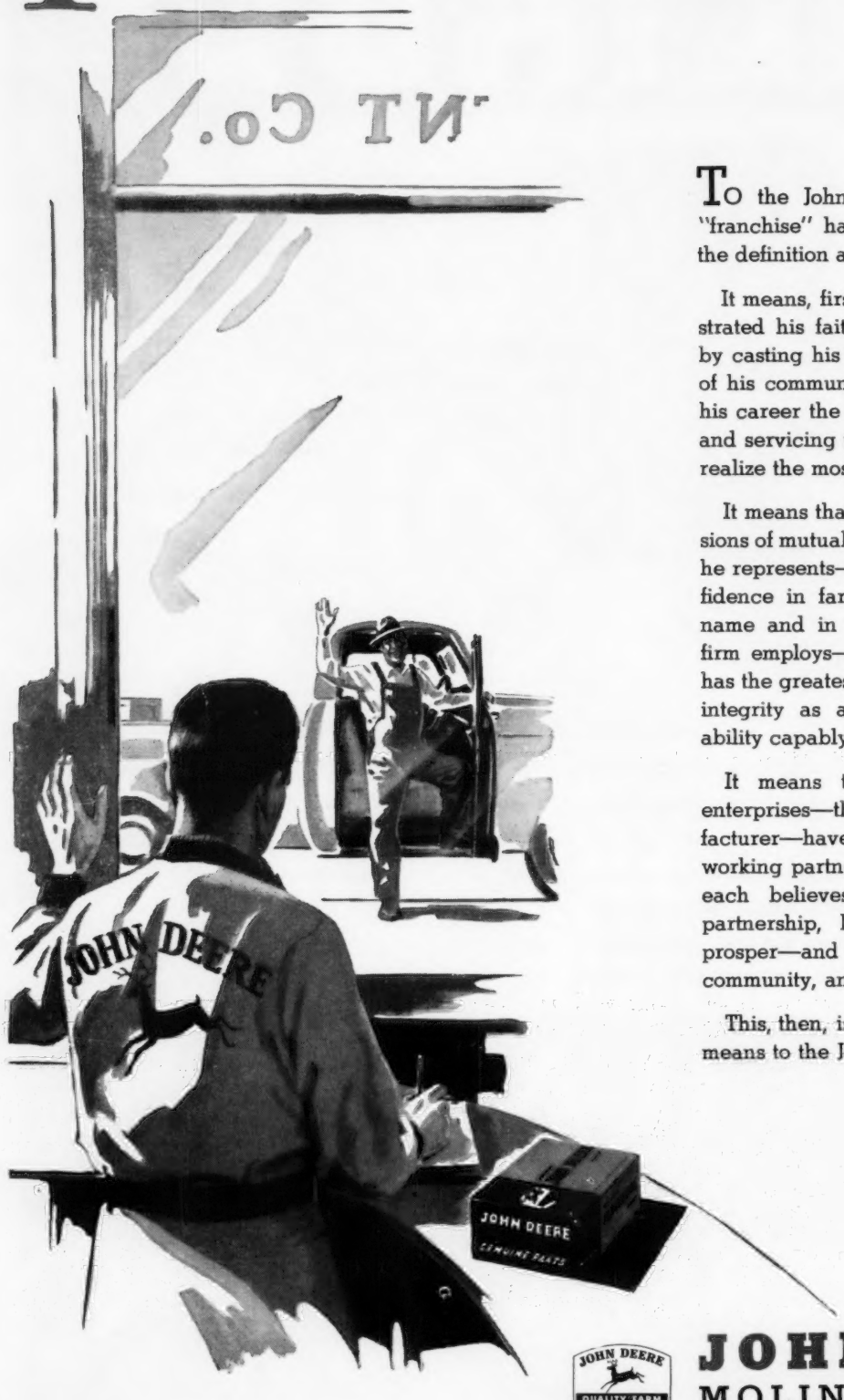
F ... is for Franchise



To the John Deere dealer, the word "franchise" has a meaning quite beyond the definition any dictionary offers.

It means, first of all, that he has demonstrated his faith in American agriculture by casting his lot with that of the farmers of his community—that he has chosen as his career the satisfying task of supplying and servicing the equipment they need to realize the most from every acre.

It means that he has exchanged expressions of mutual trust with the manufacturer he represents—that he has the fullest confidence in farm equipment bearing that name and in the business methods that firm employs—and that his manufacturer has the greatest confidence in the dealer's integrity as a businessman and in his ability capably to represent that line.

It means that these two individual enterprises—the dealer and his manufacturer—have joined in a permanent working partnership with the farmer, and each believes firmly that, under this partnership, he can profit, grow, and prosper—and best serve agriculture, the community, and the nation.

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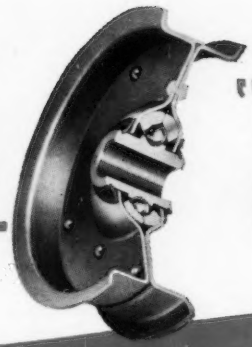
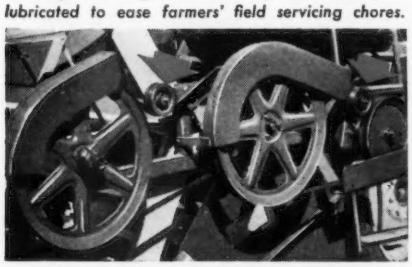


help keep tight check on costs on MASSEY-HARRIS Combine

Massey-Harris Self-Propelled Grain Combine moves into action. Close-up of tightener pulley shows how BCA package unit ball bearings are incorporated in design. Bearings are effectively sealed and pre-lubricated to ease farmers' field servicing chores.



BCA tightener pulley bearings used in the design of the Massey-Harris Self-Propelled Combine provide outstanding benefits for the manufacturer and farmer alike. The efficient, low-cost *package unit* of pulley and bearing simplifies and speeds up assembly for the manufacturer. The pre-lubricated bearing is effectively sealed against grit and dust, eliminating extensive field servicing chores for the busy farmer.

Massey-Harris-Ferguson, Ltd., like many other big farm implement manufacturers, rely on BCA for ball bearing dependability. BCA Idler Pulley Assemblies find application in numerous farm equipment: combines, hay balers, forage harvesters, grain elevators, corn and cotton pickers, spreaders. Sheave design can be varied for use with flat belts, V-belts, or chains. If you have a bearing problem, BCA engineering cooperation and design assistance will provide the right solution.

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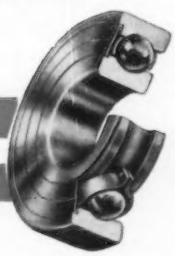

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Bowers & Kelly, land clearing contractors, headquartering in Pecos, Texas, did the work shown at right *in one year!* Shown here is a typical clearing operation with a Cat D8 Tractor and a special root cutter. The part of the cutter buried in the ground is a heavy blade fastened to the upright standards of the cutter, cutting the brush at bud ring depth. This effectively destroys the mesquite, chaparral and black brush found in this area. It is equally effective in willows, saplings, dense brush native to other areas. For rugged work, Bowers & Kelly have standardized on Caterpillar equipment. As F. B. Bowers says, "I've learned the hard way . . . it pays to standardize on Caterpillar products. I've proved that competitive equipment can't take the gaff of our operation. We have one Cat D7 Tractor that has gone more than 9,600 hours with practically no repairs."

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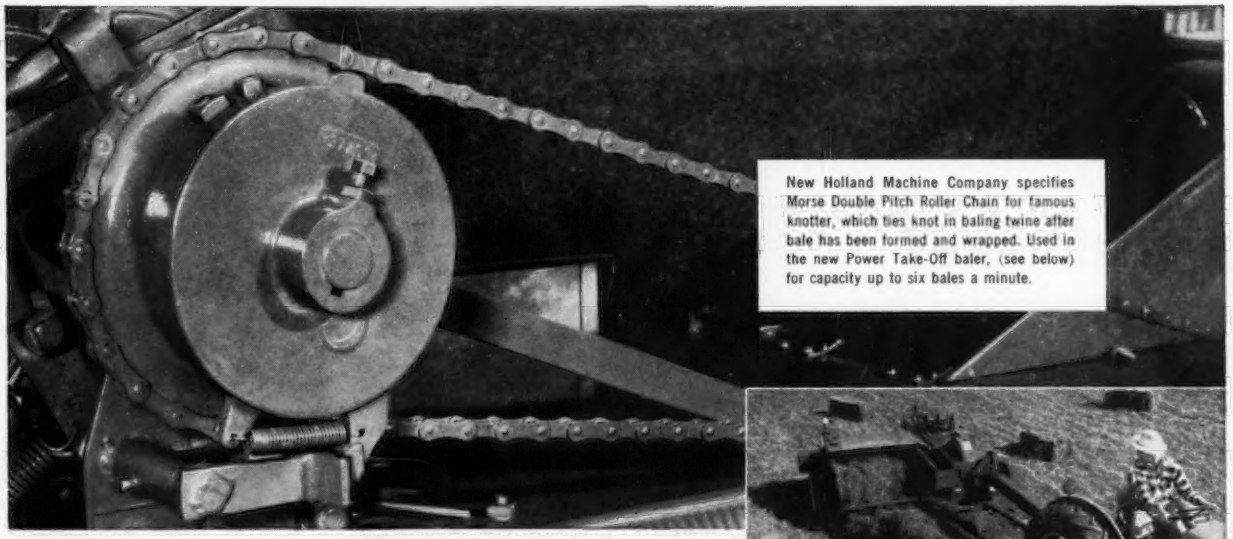

New Holland Machine Company specifies Morse Double Pitch Roller Chain for famous knotter, which ties knot in baling twine after bale has been formed and wrapped. Used in the new Power Take-Off baler, (see below) for capacity up to six bales a minute.

Quick refresher facts

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You gain parts economy and increased customer satisfaction when you equip your farm machinery with Morse Double Pitch Chains.

DESIGN, ECONOMY FACTORS

You cut problems raised by gradual pitch elongation to a new low with these tough, precision-built, steel chains. Your customers will welcome freedom from maintenance cost, time loss and annoyance.

Morse Double Pitch Chains come in two series, *Power Transmission* and *Conveyor*. Both series are adaptable to a maximum range of applications, can be used with standard and special attachments.

Double Pitch Chains are ideally suited for applications where rotative speeds are low and the power to be transmitted is within the capacity of a single strand chain. In comparison with standard roller chains, they weigh less, cost less; with proper care, they provide the same long life. Parallel strands wear evenly—a particular advantage for conveying work.

STAMINA FACTORS

Morse Double Pitch Chains will wear longer, give more satisfactory, all-round performance, help reduce downtime. Here are a few reasons:

1. PINS. Heat-treated special high-nickel, fine grain alloy steel pins have extremely hard case for wear resistance, tough inner core for high strength.

2. PIN LINKS. In Morse Double Pitch Chains, heavy press fit holds pins immobile in pin link plates. Accuracy of assembly and close fit tolerance of pin and plate components assure proper clearances between pins and bushings.

3. BUSHINGS. Morse bushings are case hardened and heat treated for maximum wear. Smooth inner bearing surfaces and true roundness help eliminate pin scoring, increase joint life, reduce elongation.

4. ROLLERS. Rollers, processed from special alloy steel, are shot-peened for maximum wear and resistance to shock.

5. LINK PLATES. Morse link plates are specially treated to obtain maximum structural strength and maximum endurance qualities necessary in highly stressed tension parts.

If you'd like sound, effective engineering help on drive design, attachment selection, or any related mechanical-power-transmission problem that's bothering you, let us put you in touch with one of our skilled Morse Men. Or, write for Catalog C52-52. MORSE CHAIN COMPANY, 7601 Central Avenue, Detroit 10, Michigan.

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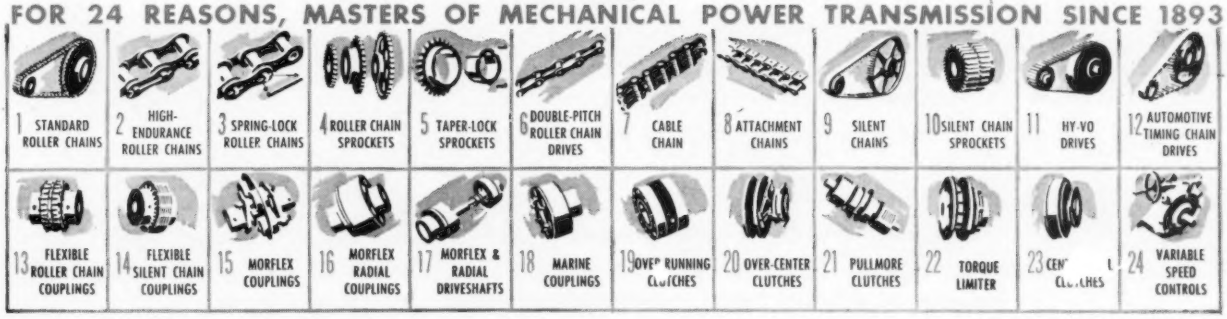

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Tests made over a three-year period by the Farm Machinery Section, U. S. Department of Agriculture, and reported in a feature article by I. F. Reed and W. F. McCreery in the February, 1954, issue of Agricultural Engineering, confirm what we have long claimed for Ingersoll Heat Treated Discs.

Cross-rolling of the steel does "have a marked effect on impact and fatigue resistance."

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AGRICULTURAL ENGINEERING

VOL. 36 JANUARY, 1955 NO. 1

The Steel Squirrel

Fred L. Hill and R. W. Brazelton
Assoc. Member ASAE

Machine designed to speed up ladder operations of pruning, thinning, and picking in the production of deciduous fruit, and to reduce over-all costs of operation

PRUNING, thinning, and picking expenses represent more than one-half of the total operational costs of producing deciduous fruit (Table 1) under California conditions. In areas where the high irrigation costs and pest control problems peculiar to California are not encountered, these three operations may well represent an even higher percentage of total costs. Pruning, thinning, and picking all involve work in the tree, usually on a ladder. Consequently a machine designed to substantially improve ladder operations will make the greatest impact on over-all costs.

Many attempts have been made to build machines to replace the ladder, but they have usually been found costly and inefficient; and a majority have been multiple units designed for use by more than one man at a time. Some were

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1954, on a program arranged by the Power and Machinery Division.

The authors—FRED L. HILL and R. W. BRAZELTON—are, respectively, chief engineer and junior agricultural engineer, Blackwelder Mfg. Co., Rio Vista, Calif.

Acknowledgments: The authors desire to acknowledge the valuable assistance of V. W. DeTar, farm adviser, Solano County, California, during the years of development and testing of the steel squirrel, including the performance studies he made of both ladder and squirrel operations. For data and suggestions received, the authors are indebted also to C. H. Zuroske, assistant professor of agricultural economics, State College of Washington; W. R. Conley, orchardist, Hughson, Calif., and to the following men associated with the University of California: Roy Bainer, chairman, department of agricultural engineering; H. B. Walker, professor emeritus of agricultural engineering; Paul W. Moore, associate specialist, citrus experiment station; Arthur Shultis, extension economist; Edward C. Koch, farm adviser, Santa Cruz County; Burt B. Burlingame, extension economist; Fred H. Petersen, farm adviser, Sutter County; Doyle Reed, extension economist, and R. D. McCallum, farm adviser, San Benito County.

TABLE 1. ORCHARD OPERATIONAL COSTS*

CROP	TOTAL PREHARVEST & HARVEST COSTS	PRUNING	THINNING	PICKING	TOTAL PRUNING THINNING & PICKING	% OF TOTAL OPERATIONAL COSTS
YELLOW NEWTON APPLES SANTA CRUZ COUNTY, CALIF. 1954	$557.05	$90.50	$94.25	$121.00	$305.75	54.9%
CLING PEACHES SUTTER COUNTY, CALIF. 1954	$447.33	$54.50	$109.00	$84.00	$247.50	55.4%
APRICOTS SAN BENITO COUNTY, CALIF. 1953	$326.37	$67.50	$36.00	$76.44	$179.94	55.1%
FREESTONE PEACHES SOLANO COUNTY, CALIF. 1953	$230.47	$28.16	$22.01	$82.81	$132.98	57.7%

*Actual preharvest and harvest costs including materials, such as sprays, fertilizers, heating oil, etc., but not including items such as building and tree depreciation. Costs are on a per-acre basis. Data from University of California Agricultural Extension Service reports

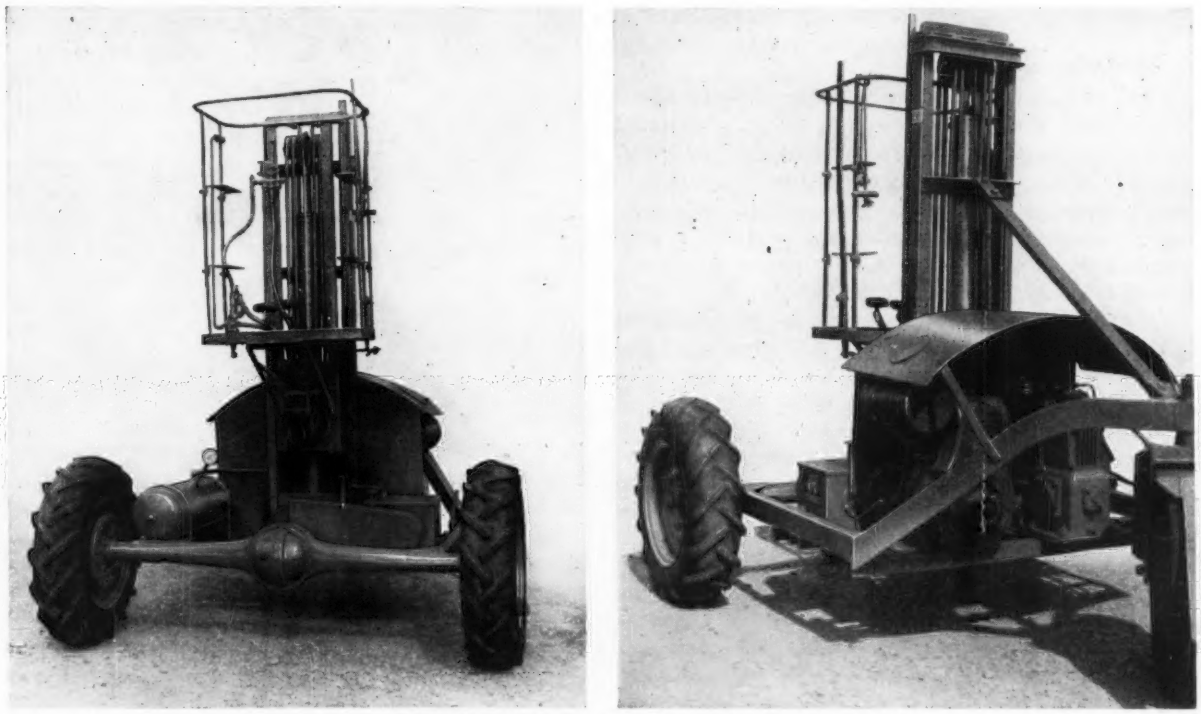


Fig. 1 Front and rear views of the steel squirrel

self-propelled, some of the trailer type, and others tractor mounted. Multiple-machine operation is geared to the speed of the slowest worker. Even with a smoothly coordinated team of workers, inefficiency results when trees do not require evenly distributed amounts of work. A prime defect often encountered is lack of flexibility and consequent inability of the operator to position himself quickly with ease and accuracy.

Objectives

A machine to replace the ladder need not replace a large crew, but it must aid in increasing labor output to an economical degree. It has been proved that an increase in the output per worker of 50 percent to 100 percent is highly worth while and is a practical objective in designing a machine for immediate production.

To improve ladder operations, a machine must convey the worker to any point in the tree quickly and with ease. It must negotiate all types of orchard terrain and ground conditions in fair weather or foul. By including a source of compressed air to operate pneumatic orchard tools now available, it should do more than just replace the ladder; for the use of such tools combined with the proper machine action can reduce operator fatigue to give higher production and permit an elderly owner to continue doing much of the orchard work himself without risking the use of a ladder. To increase its annual use, it should be adaptable to spray painting and other farm operations when not working in the orchard.

The machine must be competitive with other such equipment and other methods currently in use. It must be inexpensive, durable, and reliable, yet simple to maintain and operate. It must be safe, convenient, and easy to use. A standard machine should be developed to satisfy a majority of orchard conditions and reduce the manufacturing costs by making mass production feasible.

Design Details

The main frame of the "squirrel", the machine described in this paper, is triangular in shape (Fig. 1). A standard automotive rear-axle assembly forms the base of the triangle. The apex of the triangle carries a free-castering third wheel. Power applied to the pinion drives the axle assembly in the conventional manner while steering is accomplished by braking either drivewheel to pivote sharply through 360 deg on a turning radius of 74 in for the 10-ft model.

A 6½-hp standard air-cooled gasoline engine propels the unit and also supplies power to the air compressor. The compressor consumes about 2 hp when operating at approximately 800 rpm with a piston displacement of 11.3 cfm. A 1250-cu in compressed-air receiver tank is mounted beside the compressor. An unloader between the receiver tank and the compressor intake valve mechanism permits the compressor to idle under no load when the receiver is up to the desired pressure. The cutout-cutin differential is about 15 psi and is normally set for 125-140-psi operation.

A V-belt drive from a second sheave on the compressor supplies power to the transmission. Two disk-type clutches are located on the transmission input shaft. Movement of the central shifting collar rearward engages one clutch and supplies power to a gear drive to turn the output shaft in one direction. Movement of the shifting collar forward disengages the gear-drive clutch and engages the chain-drive clutch to turn the output shaft at the same speed as the the gear drive; but, of course, in the opposite direction. When the shifting collar is centered, both clutches are disengaged and the transmission is in neutral. A chain drive connects the transmission output shaft to the sprocket on the differential pinion.

Fig. 2 This view shows the steel squirrel as used for picking fruit

A telescoping channel-type tower assembly and the pneumatic-lift cylinder are rigidly mounted at the center of the frame. The pneumatic cylinder, as it extends, raises the inner tower. A cable passing over a sheave mounted at the upper end of the inner tower lifts the roller-mounted workers' platform, called the "crow's nest", at twice the speed at which the cylinder extends. Two models lift the operator 10 or 12 ft. An accessory permits two additional feet of height on either model. A pneumatic-lift cylinder is used to take advantage of the fast action of the compressed air already available for pneumatic tool operation, thereby eliminating the need for a separate and expensive hydraulic system. A line lubricator in the crow's nest, near the lift cylinder and air tools, supplies SAE 10 motor oil with a metered venturi action to the air-lift cylinder and tools only during operating cycles.

All controls are mounted on the crow's nest to enable the operator to entirely maneuver the machine at any time regardless of his height above the ground. The air and brake hoses are routed over sheaves in the same manner as the lift cable. One end of each is attached to the crow's nest and rises and descends with it. A hand or foot-operated air valve allows the operator to raise or lower himself by foot control while continuing to use both hands to work in the tree. An air outlet in the crow's nest provides for attachment of standard pneumatic tools.

TABLE 2. PICKING OPERATION – LADDERS VERSUS STEEL SQUIRREL

CROP	LADDER	SQUIRREL	SQUIRREL %
APRICOTS - CASE I*	1000#/10 HR DAY SEASON AVERAGE	1655#/10 HR DAY SEASON AVERAGE	165.5 %
APRICOTS - CASE II*	1.9 BOXES PER HOUR	3.8 BOXES PER HOUR	200 %
PEARS - CASE I*	1455#/10 HR DAY SEASON AVERAGE	3045#/10 HR DAY SEASON AVERAGE	209%
PEARS - CASE II*	5.08 BOXES/HR SEASON AVERAGE	8.14 BOXES/HR SEASON AVERAGE	160.3%
PEARS - CASE III*	5-7 BOXES/HR PIECEWORK 3-5 BOXES/HR HOURLY RATE	7-9 BOXES/HR HOURLY RATE	APPROX. 200 %
APPLES**	5.95 MINUTES PER BOX	3.56 MINUTES PER BOX	167 %

*Data from 1949 and 1950 annual reports by Verne DeTar, Solano County farm adviser, to California state office.

**Data from 1952 and 1953 studies by C. H. Zuroske, assistant professor of agricultural economics, State College of Washington.

A pair of conventional automotive master brake cylinders under the crow's nest floor supply pressure to brake cylinders in the main drive wheels.

By use of a square rod and sliding square tube arrangement and suitable linkage, a hand lever in the crow's nest controls the action of the clutches in the transmission below. Both clutches are disengaged with the lever in the vertical position. Movement of the lever engages the proper clutch to move the machine in the direction of lever movement. Control is positive, regardless of elevation of the crow's nest, so that it is not necessary for the operator to descend to move the machine around through the orchard.

Performance

Five years of field tests show that on the over-all average, the worker on the squirrel can do from one and one-half to two times as much as he can do on a ladder (Tables 2, 3, and 4 and Fig. 2). Extremes range from no improvement to 500 percent to 600 percent under special conditions. The same worker's output will vary under varying conditions.

The Solano (Calif.) county farm adviser has used a machine since 1949, while keeping accurate records of performance (Table 2) and costs. To date, after 5,000 hr of operation, the machine is carrying its full work load and is functioning normally. Depreciating the original cost over 10 years and a modernization overhaul over 6 years, and figuring interest at 5 percent on half of the original cost plus all gas, oil, and repairs charged directly, the actual cost of owning and using the squirrel to date has been 33¢ per hour. The machine has long since paid for itself and is now paying the owner. Other owners report hourly costs as low as 21¢, with the difference being attributed mainly to engine life and availability of repair facilities.

Operation of the machine requires no specially high degree of skill, so that a few minutes or a few hours of practice at most will bring good results in most cases.

The machine is widely adaptable. It has worked successfully in the subtropical avocado and orange groves of southern California and in the other types of orchards throughout the year, with work ranging to pruning in the snow-covered orchards of the Pacific Northwest.

The increased ease of operation made possible by the combination of pneumatic tools and maneuverability of the

TABLE 3. CLING PEACH OPERATIONS*

OPERATION	LADDER HRS / YEAR	SQUIRREL HRS / YEAR	SQUIRREL %
PRUNING	792	480	165 %
THINNING	336	240	140%
PICKING	348	200	174 %
WIRING	94	40	235%

*Data from records on 30-acre cling peach orchard of W. R. Conley, Hughson, Calif.

squirrel has enabled some operators to report improved pruning quality, resulting from "detailed pruning," that is, more small cuts, fewer big cuts, and more selective pruning of "weak wood."

Maximum performance is obtained by careful selection of air tools. Many factors govern the choice of tools most desirable for a particular orchard. Fast cutting action and light weight are important. The size and hardness of wood

TABLE 4. PRUNING OPERATION – ORANGES LADDERS VERSUS STEEL SQUIRREL*

TYPE OF PRUNING	LADDER	SQUIRREL	SQUIRREL %
HAND HEDGING TO OPEN ROW	8+ TREES/HR	24 TREES / HR	300%-
LIGHT CUTS IN TOP AND SHOULDERS OF TREE	4 TREES/HR	16 TREES/HR	400%
SKELETONIZING (ALL LIMBS BACK TO 1" WOOD)	1-1/2 HRS/TREE	20 MIN / TREE	450%

*Data from 1954 studies by P. W. Moore, associate specialist, Citrus Experiment Station, University of California, Riverside.

to be cut determines shear size. The compressed air supply for the squirrel will adequately handle most commonly used air tools with the standard compressor installation without impairing maneuverability. In heavy pruning work which requires large pneumatic saws, the additional air needed can be readily supplied, without impairing maneuverability, by installing the next larger size compressor at a small additional cost.

Conclusions

1 The average man can be expected to do one and one-half to two times as much work on the squirrel as on a ladder with a wide range of variation possible depending upon the operator, orchard conditions, and the type of work being done.

2 Intangible benefits hard to evaluate will become evident:

(a) Improved quality of pruning and consequent yield increase

(b) Ability to get orchard work done on time at the right stage of maturity, condition of weather, and when encountering labor shortage

(c) Saving of a light crop or last portion of a crop which could not be economically harvested by ladder workers

(d) Being able to attract and hold better men for steady employment. Good tractor and equipment operators will frequently move on when the ladder-climbing season approaches.

Pole Pier Foundation for Farm Buildings

Deane G. Carter, Life Fellow ASAE; J. O. Curtis, Assoc. Member ASAE; and H. L. Wakeland, Assoc. Member ASAE

AN EXPERIMENTAL foundation developed at the Illinois Agricultural Experiment Station may have wide application as a simple, low-cost base structure for manufactured, utility-type farm buildings. The foundation consists of pole piers topped by a box sill made with 2 x 6 girts and a 2 x 10 plate. The curtain wall is 2-in center-matched planking extending from the sill to 12 in or more below grade.

The experimental structure was built with pressure-creosoted pine posts and both creosoted and Wolmanized planks. Posts were 6-in top diameter, 6½ ft long. They were set about 4 ft in the ground and cut off at the sill line 2½ ft above grade; however, 6-ft posts set 3½ ft deep should be adequate. Posts were spaced at 5-ft intervals. Planks for the curtain wall should be bought in 16-ft lengths to span three 5-ft intervals and allow for squaring up and proper nailing.

The primary purpose of the study was to devise a method of construction for fast erection, low cost, use of home labor, and utilization of the increasing supply of treated wood. This particular foundation was used for a "frameless," arch-roofed, galvanized-steel utility building. The pole pier foundation appears to be entirely suitable for the various manufactured buildings of the clear-span utility type.

Preliminary design indicated that the post and curtain wall construction was well within the limits of adequate design. The calculated outward thrust due to dead load and a 30-lb combined snow and wind load was 430 lb per linear foot. The vertical load was about 475 lb per linear foot. Sufficient resistance to loads and pressures was obtained by setting 6-in-diam posts not less than 3½ ft deep and carrying the curtain wall one foot below grade.

As a part of the experimental procedure, bench marks were set and readings taken on the foundation. Thus settlement or spreading can be detected if they occur at any time. Possible spreading can be offset by anchors in or under the floor, and turnbuckles placed at 15-ft intervals. If settlement occurs, future construction might be specified to require a concrete footing at the base of the posts.

The cash cost of this foundation is determined by the local price of treated timbers and the amount the owner assigns to labor. This particular 40 x 60-ft foundation required 38 posts, 6 in by 6½ ft; 200 linear feet 2 x 10; 336 linear feet 2 x 6 planks and 1,176 board feet of 2-in center-match. Local costs might vary above or below $450. About 132 hr of farm labor was used. The actual cost was approximately equal to contractors' estimates for the cost of forms for a poured concrete foundation.

The foundation was built entirely with farm type labor and farm tools. Surface soil was scraped from the site to a

(Continued on page 30)

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The authors—DEANE G. CARTER, J. O. CURTIS and H. L. WAKELAND—are, respectively, professor of farm structures, assistant professor and instructor in the department of agricultural engineering, University of Illinois.

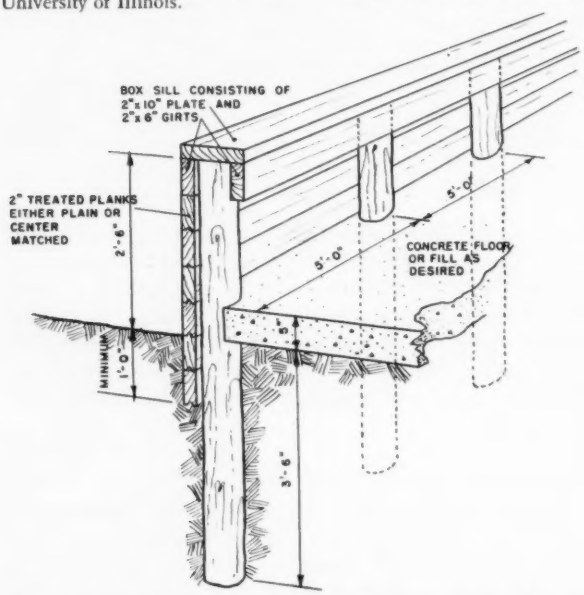


Fig. 1 Pole pier foundation for utility-type buildings. Depth should range from 3 to 4 ft, according to the size and type of structure. The curtain wall should be carried 1 ft below grade

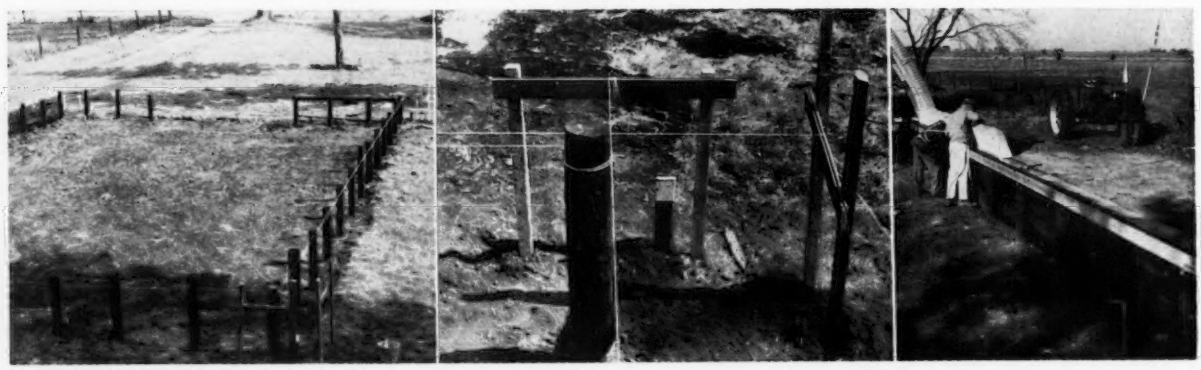


Fig. 2 Pole pier foundation during construction. *(Left)* Poles were aligned along the outside edge. Tops were cut to length later. *(Center)* Batter board, chalkline, and carefully aligned corner posts assured proper layout. *(Right)* Completed pole pier foundation and start of building assembly. After grading and fill, this foundation will extend 2 ft above the floor

Tractor Engine Design for Tomorrow

T. H. Morrell and H. K. Dommel
Member ASAE

Engineers Conduct Exploratory Research Program to Push Back the Horizon on High Compression

THE best all-around tractor power plant is one that does the intended job most effectively and at the lowest total cost to the individual consumer.

In analyzing the trends in both quantity and quality of the various fuels available to farmers, it was found that gasoline continues to be the most widely used fuel. In addition to its broad availability the antiknock quality of gasoline has been steadily increasing. For example, Fig. 2 shows that the octane number of regular gasoline, as determined by the motor and research methods of testing, has increased from 75.5 and 80 in 1947 to 81 and 85.5 in 1954. These are the two accepted methods of determining the antiknock quality of gasoline. In studying this quality trend we found that the average octane number of today's gasoline is higher than that of the premium gasoline of 1947. It is generally accepted that this upward trend will continue.

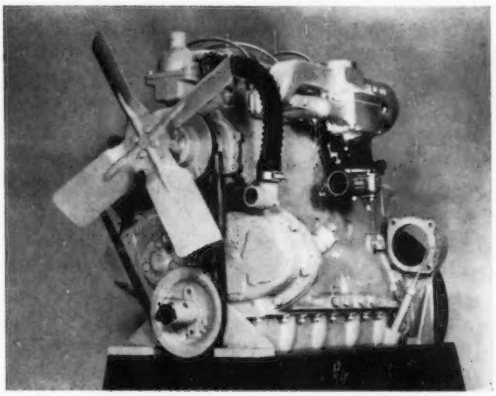


Fig. 1 The experimental tractor engine, XO-121, used by engineers of The Oliver Corporation in a basic research program to explore the possibilities of higher compression ratios

Just what are the prospects of taking advantage of this gasoline quality trend by engine design? What does this octane number increase mean in terms of engine efficiency? These questions recall our experience back in the early 1930's when we capitalized on the improved gasoline octane number by introducing what was then a high-compression tractor—the Oliver "70". We learned from this development that compression ratio was the principal key to transforming higher octane value into engine efficiency. This finding did not come easily. It required thorough study, not only of higher compression ratios but their proper integration with all of the engine design factors which are related to power and economy.

In studying the potentialities of projected fuel antiknock quality, it was considered advisable to attempt to take a giant step forward. Such a step would require a comprehensive experimental program, a program to prove whether a tractor engine of advanced high-compression design, using fuels "ahead of tomorrow" would really produce sound, practical, and realistic gains. We needed an experimental engine which could be used as a tool to accomplish this job.

To make this extension of our earlier study we called on the Ethyl Corporation. We felt that since they had been over similar ground before with automotive engines, their background would assist us in gaining the maximum potential benefits from high-compression design.

The decision to take a great forward step was predicated on the possibilities of obtaining the objectives of efficient flexible power, economy, and long life by the application of high compression and structural rigidity.

In any type of exploratory research the engineer must sooner or later take a leap in the dark. Some progress can be made by inching cautiously forward, but advancing by small increments will not always pay off when you really want to push back the horizon of knowledge and gain a sizable amount of radically new information. These principles of exploratory research certainly apply in the field of tractor-engine design. Since the introduction of gasoline engines into the farm tractor field, compression ratios have in general moved upward to over 6 to 1. Even though the returns from a continued inching forward above 7 to 1 can be worth while, we felt that there was much more to be learned by making a real leap into the future.

With the decision approved to take this leap, it was necessary to decide how high in compression ratio we should go. While it was desirable to explore this variable as far into the future as possible, we knew of no such engine research efforts which went much beyond the level of 12 to 1. This compression ratio was selected since we felt that it was far enough ahead of present practice to yield a clear-cut answer to our major question: will the high-compression route really yield major improvements in power and economy? The experimental fuel prepared for the compression ratio of 12 to 1 has basic characteristics similar to present-day commercial gasolines, but has an antiknock value beyond the conventional octane number scale. It is estimated that its equivalent octane number is approximately 101 motor method and 107 research method.

With the compression of 12

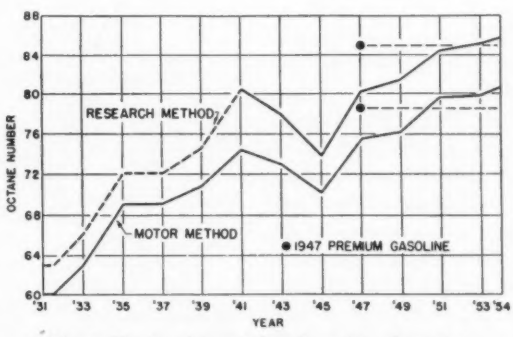


Fig. 2 The trend in anti-knock quality of regular gasoline

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Power and Machinery Division.

The authors—T. H. MORRELL and H. K. DOMMEL—are, respectively, chief engineer and supervisor of experimental engineering, The Oliver Corporation.

Acknowledgment: The authors express gratitude to Ethyl Corporation, Hercules Motors Corporation, and to all suppliers of accessory equipment for valued engineering assistance given in connection with this research program.

to 1 selected, the necessary theoretical calculations of power output were made. We established the displacement of the engine so that its power output could be adequately handled by our 3-4 plow model 88 tractor chassis which we feel is a practical size tractor. On this basis, we would later be able to make some fairly direct comparisons of results. For this engine we selected a diesel block with a displacement required to produce the power output desired and which had ample rigidity to provide a sufficient safety factor. A cylinder head was designed having a combustion chamber configuration which had demonstrated it was capable of utilizing high fuel anti-knock quality effectively. Conventional manifolding and carburetion were used. A 12-v ignition system was selected. It was designed to be functional and practical, and not a hot-rod type of engine.

We would be presumptuous indeed at this point so say that our initial specifications for the engine represented the final word in design. In any exploratory design a certain number of compromises are forced on the engineer, and already many features have been tested and modified as necessary compromises were explored. Again, we would like to emphasize that the present design as agreed to and the experimental engine as built do not represent anything in the way of a frozen or finalized research tool. It is not, nor will it ever be, a production engine. It is a research tool to be worked with, to be studied, and it undoubtedly will be modified still further as our investigations continue. However, with its present specifications we believe it is one of the most useful tools ever developed in the long history of tractor power improvement.

We refer to the engine as the XO-121, the X for experimental, the O for Oliver, and 121 denoting a 12 to 1 compression ratio. The XO-121 is a 199-cu-in, overhead-valve, 4-cylinder engine with a bore and stroke of 3¾ by 4½ in, and a governed speed of 1600 rpm.

The first dynamometer studies were directed toward finding out whether our earlier calculated enthusiasm could be justified. The criterion for this evaluation was primarily power output and fuel economy.

Results showed that our efforts had paid off. At best economy carburetor setting and with all accessories, the engine developed 57.5 corrected brake horsepower at the flywheel with a fuel economy of 0.385 lb per hp-hr. This was well within the range which had been predicted, and, to the best of our knowledge, we had constructed the most efficient tractor engine ever built. Further checks indicated that friction, torque, and roughness were quite satisfactory. We naturally, were interested in other yardsticks of performance such as volumetric efficiency, brake mean effective pressure, fuel distribution, and thermal efficiency. Checks of these items also supported the conclusion that the first progress report was an exceptionally good one.

To get an idea of the magnitude of the improvement shown in the XO-121, we made some comparisons at this point with the model "70" engine of 1935 and with our present model "77" (Table 1). All three engines have substantially the same displacement and are governed at approximately the same speed. On the basis of horsepower output per cubic inch, we were 92 percent better than the "70" and 44 percent better than the model "77". Looking at fuel economy, the gains were 36 percent and 30 percent, respectively. There is no doubt about the value of the gains resulting from a well-designed, high-compression engine which takes full advantage of gasoline anti-knock quality. Furthermore, it has been demonstrated that these gains can be realized without resorting to unconventional engine construction.

From this point on, our efforts were divided into two paths. It was desirable to install the experimental engine in a conventional tractor chassis for the purpose of belt and drawbar comparison tests, and at the same time we knew that further dynamometer studies and refinements were needed.

For several weeks belt and dynamometer tests were under way simultaneously, and we have to date approximately 1100 hr of test experience with this design.

We also gained valuable experience with field drawbar work, such as the evaluation of rear-wheel torque characteristics and the response of the engine to governor action and rate of load application. We wanted to be sure that such an engine would *produce*, not only on the dynamometer, but also under actual field conditions of variable speed and load at both part and full throttle.

Table 2 shows belt performance of the XO-121, the "70" and the "77". For the sake of power comparisons, either 100 percent maximum or operating maximum can be used since both show the XO-121 to be approximately 92 percent and 48 percent better, respectively, than the "70" and "77". Looking at fuel economy, the gains were 40 percent and 32 percent. *(Continued on page 25)*

TABLE 1. COMPARISON OF PERFORMANCE OF THE XO-121 WITH OTHER OLIVER TRACTOR ENGINES

Engine Dynamometer

Models	"70"	"77"	"XO-121"
Displacement, cu in	201	194	199
Compression ratio	6.50:1	6.75:1	12:1
Governed speed, rpm	1500	1600	1600
BHP, 100% maximum corrected	31.6	41.22	60.9
BHP, operating maximum observed	28.4	36.4	54.0
Horsepower-hours per gallon, operating maximum	11.85	12.40	16.07

TABLE 2. COMPARISON OF PERFORMANCE OF THE XO-121 WITH OTHER OLIVER TRACTOR ENGINES

Belt

Models	"70"	"77"	"XO-121"
Displacement, cu in	201	194	199
Compression ratio	6.50:1	6.75:1	12:1
Governed speed, rpm	1500	1600	1600
BHP, 100% maximum corrected	29.56	38.82	56.90
BHP, operating maximum observed	26.57	34.34	51.10
Horsepower-hours per gallon, operating maximum	11.07	11.73	15.50

TABLE 3. COMPARISON OF PERFORMANCE OF THE XO-121 WITH OTHER OLIVER TRACTOR ENGINES

Drawbar

Models	"70"	"77"	"XO-121"
Displacement, cu in	201	194	199
Compression ratio	6.50:1	6.75:1	12:1
Governed speed, rpm	1500	1600	1600
DHP, 100% maximum corrected	26.25*	34.20	48.50
DHP, operating maximum observed	23.60*	30.19	43.60
Horsepower-hours per gallon, operating maximum	9.82*	10.33	13.24

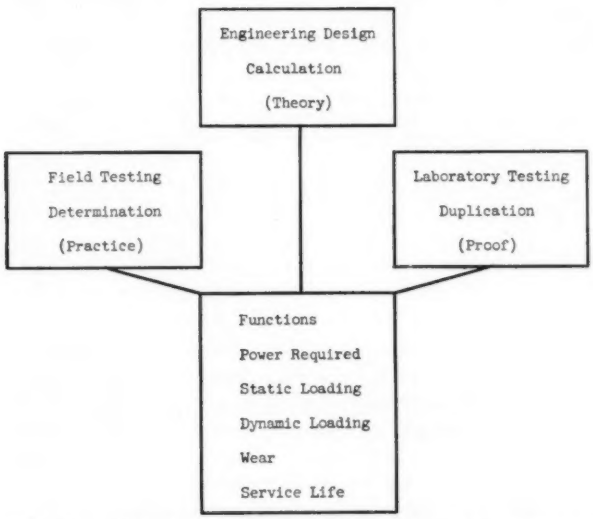
* Steel wheel data adjusted to show performance on rubber tires.

Correlation of Design and Testing

W. G. Miller

Design engineer evaluates field and laboratory testing of farm machines in relation to engineering design

IN THE development of agricultural machinery, field testing has always played a prominent part. When the farm equipment industry was in the so-called "blacksmith era," it was the custom to cobble up a machine in the experimental shop and then take it out to the field for test. Further cobbling was done in the field to arrive at a machine that was functionally satisfactory and structurally sound. The machine was put to work under varying field conditions in an attempt to simulate normal operation in the hands of the customer. Once the first tests were completed, it was customary to bring the machine back to the experimental shop and clean up the design a bit. Then a number of machines would be made up by hand and sent out into the field for normal work. After further changes on these machines as a result of field test, a sample machine would be built in the experimental shop. This machine would then be disassembled and each part stamped with a part number and with a large S and painted a repulsive brown color. These were the official samples that went out to the factory to be reproduced and assembled into production machines.



This chart shows how both field testing and laboratory testing are complementary to engineering design in dealing with the same factors with which the designer is mainly concerned; functions, power requirements, static and dynamic loading, wear, and service life.

Although there is some evidence to indicate that we have not completely emerged from the blacksmith era, it is unquestionably true that the farm equipment industry has made great strides, and the machines that are being built today are better engineered and better manufactured than ever before. Among the contributing factors to this technological advancement has been the more intelligent use and practical correlation of laboratory and field testing.

Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Burlington, Vt., August, 1954.

The author—W. G. MILLER—is chief development engineer, haying machinery section, Massey-Harris-Ferguson, Ltd.

For many years the laboratory played little part in the development of agricultural machines. Its functions were limited, metallurgical checks of steel and cast iron samples, physical testing of materials and, once in a while, some form of a setup to check a belt or chain drive but without any definite relationship to field conditions.

In order to consider intelligently the correlation between engineering design, laboratory testing and field testing, it is necessary first of all to have clearly in mind what is meant by the three terms.

Engineering design is the science or art of incorporating new or existing ideas into new or existing products to fulfill some definite required purpose. It is the development of a complete machine or structure, or the element of a machine or structure, to perform a specific function at the lowest cost consistent with acceptable service life. Basically there are four major considerations in any product design: (1) function, (2) service, (3) cost, and (4) appearance. All four are interrelated and interdependent. Generally speaking, the designer's purpose is to develop the best functions and the best appearance for the least cost. Engineering design is essentially the economic use of materials. It is said that the engineer can do for one dollar what any fool can do for two.

At this point it would be well to emphasize the fact that engineering design for an agricultural machine is not as simple as it may seem. A broad technical background is required and many factors must be considered. The qualifications of a good design engineer for agricultural machinery may be summed up as follows:

- A good general knowledge of farm practice and field operations
- Familiarity with the latest developments in scientific agriculture
- A thorough training in the fundamentals of engineering science
- Knowledge of up-to-date foundry practice, pattern making, and metallurgy
- Knowledge of machine shop practice and tool design
- Knowledge of sheet iron and press work
- Knowledge of forging practice and die design
- Knowledge of new engineering materials
- Knowledge of manufacturing costs
- Knowledge of service problems
- Knowledge of sales problems, domestic and export, and general merchandizing and part sales.

With all these factors in mind, and considering the limitations of the machine tool equipment available for manufacture of the proposed machine, the design engineer tackles the problem of machine development.

Like the classic traveler in the Mediterranean, passing between Sicily and the Italian coast, who had to avoid on the one hand the whirlpool of Charybdis and on the other hand the rock Scylla, with its siren voices that tended to attract him to his doom, the engineer has to steer a middle

course between two extremes, each of which would be equally fatal to his purposes. The two extremes to be avoided by the engineer in design are, first, *overdesign,* which leads into the whirlpool of high manufacturing cost, high sales price, customer resistance, low volume and ends up in an unsuccessful machine. On the other side, and equally as fatal, is the danger of *underdesign,* and here the engineer must always be on his guard against the siren voices (usually sales or production) that lure him to sacrifice quality and capacity in the interest of lower cost. The final result is the same, but even quicker than that of overdesign, as a machine that will not stand up to perform its functions properly will not sell at all.

The value of laboratory testing and field testing and the proper practical correlation of the two is that it enables the design engineer to obtain basic data required for his design, and once the design has been completed, and the prototype machine built, it enables him quickly to find out the weak spots in the design and correct them.

Laboratory testing and field testing although correlated, are quite distinct. Field testing is the functional and physical testing of complete machines in varying and essentially uncontrolled conditions of crop, weather, soil and terrain. Its scope is operational. In other words, the machine or machines are put to work doing the kind of work they are intended to do. They are watched very closely and continuous field reports are made covering all functional or physical failures. The purpose of field testing is fourfold:

- To check the functional design of a complete machine or machine elements. (This functional design check involves the adaptability of the machine to all field conditions likely to be encountered, operator comfort, accessibility and ease of controls, visibility, etc.)
- To establish the actual working life of a complete machine or elements of a machine
- To establish power requirements for complete machines and machine elements
- To provide data for future rational design in the form of stresses, in the various machine elements both in normal working conditions and due to overloads and shock loading.

In short, field testing involves work in varying conditions, and is operational.

Laboratory testing, on the other hand, is physical or functional testing in controlled conditions that permit the repetition of tests with substantial duplication of results. Laboratory testing in the farm equipment industry is rarely functional or operational, but it almost always confined to physical and endurance testing of complete machines or machine elements.

Much more functional testing could be done in laboratories, and a great deal of time could be saved in development programs by proving functional design before field testing begins. The laboratory lends itself particularly to the functional testing of units of a machine rather than complete machines. An example is the work done at the University of Illinois on the threshing of corn. A special setup was made and high-speed photographs taken with the result that some very valuable information was obtained in much less time than could have been done in actual field operations. Generally speaking, however, the purpose of laboratory testing is:

- To establish the expected working life of a complete machine or machine elements
- To provide comparative data on strength and endurance of alternative designs of machine elements
- To provide comparative data on strength and endurance of alternative materials.

Both laboratory and field testing have essentially two ends in view, namely, to check existing design, and to provide data for future design. The chief value of the practical correlation of laboratory tests and field tests is that it permits the engineer to check his designs much more quickly than would be possible by the use of field tests alone. Apart from the very considerable saving in development costs, this will permit the release for production at a much earlier date than would otherwise be possible. In some cases a whole year can be saved and this is very important in these highly competitive days.

Accepting one definition of laboratory testing as "physical testing under controlled conditions," the use of a rigid surfaced test track can be considered a part of the laboratory work. In the physical testing of a machine structure, the test track, properly used, can give results in one month that would normally take two or three years of field testing to obtain.

Essentially the test track is a means of duplicating the stresses produced in a machine as a result of its movement over the ground in normal field work. Accelerated results are obtained by increasing the frequency of the loading and by continuous operation. In other words, the machine gets the same kind of bumps but more of them.

To establish the stresses to be developed in the track test, it is necessary to check the stresses developed in normal field operation and particularly the peak loads. The use of strain gage equipment and oscillograph records is one satisfactory way to obtain this information. The only variable in track testing is the speed at which the machine is driven or drawn over the track. For a given machine it is necessary to determine the correct track speed. This will not be the same as its normal operating speed in the field, but will be established by increasing the speed gradually until a strain pattern is produced that is essentially the same as that produced in field operation. With a properly designed test track it is possible to obtain dependable results with an acceleration of 10 to 1. By this is meant that one hour's work on the test track is equivalent to ten hours' normal work in the field. With this kind of acceleration, essentially the same type of failures will be developed on the track as are developed in the field, but in one-tenth of the time.

In this connection it should be pointed out that in most agricultural operations, due to the extremely variable conditions of soil, terrain, etc., it is difficult to establish accurately the service loads and almost impossible to duplicate service loading conditions in the laboratory. This is particularly true of the random loads occuring throughout the service life of the machine which contribute to the cumulative fatigue of stressed parts. It is therefore advisable to check track or laboratory results carefully with field test results on the same model machine, in order to establish

- That the same type of failures are being produced in both tests
- The acceleration factor, or the time to produce a given failure in the field test divided by time to produce the same failure in the laboratory or track test.

The use of portable strain-gage equipment for stress determination in field operation is profitable, not only in the testing of machine structures but also in the testing of drives of various kinds, by making an oscillograph record of the strain-gage readings and from this record establishing normal and peak loadings. By the judicious application of weight or applied friction it is possible to simulate closely the field operation in the laboratory as far as drive loads are concerned. If necessary, units can be operated in a dust box or water bath, or water spray, or any combination, in order to simulate more exactly actual field conditions. Here again it is necessary to arrive at some type of relationship between wearing out of parts in the laboratory and wearing in the field.

Acceleration factors for wear up to two have been proved to be satisfactory, and it is possible that much higher factors could be used. However, even a factor of two will permit 48 hr of field use to be simulated in a 24-hr day, or 480 hr in ten days, and not too many machines work for more than that length of time each year. Thus in the space of one month it would be possible to achieve the equivalent of three year's field wear on a given drive.

The value of this kind of testing with its accelerated results is evident. It permits the engineer to release machines for production with a great deal more certainty that their structural and mechanical life will be satisfactory. Following are simple examples presently under way and the steps taken:

Test of Mower Bar Knife Drive—

- Failures produced in field work
- Loading established in field
- Loading duplicated in laboratory
- Factor to be established.

Test of Combine Cylinder Bearings—

- Failures produced in field work
- Loading established in field
- Ambient conditions—dust—heat observed
- Loading and ambient duplicated in laboratory
- Factor to be established.

In summing up it may be said that engineering design is basically calculation and is essentially theoretical. Without disregarding in any way the contribution that imagination can and must make, the whole thought in design is a definite and deliberate procedure. In saying earlier that we have not yet emerged completely from the blacksmith era, the thought in mind was that there is still far too much guess work in agricultural machine development. Many inexcusable errors would be avoided and much time and money saved if more calculations were made in the preliminary stages of design development. It is realized of course that dynamic loading is difficult to calculate and establishing this is one of the potential values of field testing.

Field testing is basically determination, i.e., the establishing of actual facts. Functional performance, dynamic stresses, power requirements, etc., can all be established during field test. Here again much remains to be done and priceless opportunities are being lost. To put a machine through a complete field test without obtaining factual information regarding loading and power requirements is throwing away a great part of the potential value of such a test. The establishing of such facts should be considered an essential part of all full field tests.

Laboratory testing is essentially duplication, i.e., the stresses and strains actually established in the field are duplicated in the laboratory together with ambient conditions, of heat, dust, etc. Once these factors are known it is possible to prove design in the laboratory much quicker than in field testing alone.

Finally it should be noted that, while all three operations are dealing with the same factors—functions, power requirements, static loading, dynamic loading, wear, and service life—neither field testing nor laboratory testing is an end in itself but both are complementary to engineering design which is the principal responsibility of the design engineer.

Tractor Engine Design for Tomorrow

(Continued from page 22)

Table 3 shows similar performance results as measured on the drawbar. On the same basis of comparison, the power of the XO-121 is approximately 85 percent and 43 percent better than the "70" and "77", respectively, and fuel economy is 35 percent and 28 percent improved. These results proved that the outstanding performance on the laboratory dynamometer were sound and could be realized in belt and drawbar work.

In attempting to appraise the value of our work to date, we recognize that we have really just completed the first step in a basic research program. Much work still remains to be done even before we can consider how improvements found might be passed on to the farmer in the future. However, we feel that our efforts have been well rewarded and that we have answers to the basic questions that were in our minds not so long ago. These answers are as follows:

- The principle of high compression as a means of gaining power and economy in farm tractor engines is practical and sound. Both theory and application have been confirmed by this experiment at a compression ratio of 12 to 1.
- The level of improvements in power and economy at both full and part throttle are so attractive as to warrant further studies. These will include studies of compression ratios below 12 to 1 and their utilization of fuel anti-knock quality so that as improved fuel anti-knock quality is available, we will be in a position to take advantage of it. This, then, will narrow the gap between this basic research tool and current engines and fuels.
- The performance of this engine in the tractor chassis demonstrated that as far as ease of starting, flexibility, and smoothness are concerned, there are no operational problems which limit the use of compression ratios up to 12 to 1.

It should be repeated that this engine, which we call the XO-121, is a research tool, and is not an engine that will ever be in production.

The Ghaly Method of Topographic Surveys

Howard Keck

SURVEYS for planning irrigation systems on large acreages involve many hours of field and office work, much of the time being primarily with establishing contour lines. Present methods of developing topography maps generally involve the use of a party of three or four — the instrument man, rodmen and recorder—and using the plane table and alidade, transit, level or combinations of these instruments.

Considerable land in Iran is being developed for irrigated farming which involves a great deal of topographic work. Azmy W. Ghaly (Assoc. Member ASAE), an Egyptian agricultural engineer, employed as field engineer by the Iranian government in developing this land, saw the need for a more rapid method of conducting the survey and office work; thus he developed a new method for making topographic maps. Ghaly's method differs from conventional methods in that he assigns a definite pattern to the movement of the rodmen, offers a wider selection of surveying instruments and introduces a new operation and man (the sighter).

The method makes use of two established positions, one occupied by the instrument man (A) and the other by the sighter (B), from which both men take radial lines of sight (Fig. 3) on the rodman. The instrument man plans his work so that he will have his rodmen coming directly toward him along a given radial line projecting out from his station. Thus depending upon the condition of the terrain, he will designate the rodmen to follow inward on a radial line starting from say 000 deg and progressing around the boundary in either a clockwise or counterclockwise direction, coming in on every 10 deg or so of the circle towards and passing on through and outwards 180 deg from the initial position. The rodman does not have to continue on out on the opposite azimuth he started on, but it may prove convenient. The instrument man takes a reading every time the rodman stops and also keeps him on line.

Now each time that a shot is taken, the sighter sights along his sight rule (plane table and rule; an alidade can be used) and makes a mark on the paper attached to his board. This paper (Fig. 1) has concentric circles drawn on it which can be lettered or numbered to correspond to the radial lines being used by the instrument man. Thus each time a shot is taken the sighter sights and makes a mark on one of the concentric circles corresponding to the proper radial line. This mark is a projection from the center of the concentric circles which is a pivot for the sight rule.

It is evident then that each level shot is located by two

Paper prepared expressly for AGRICULTURAL ENGINEERING.

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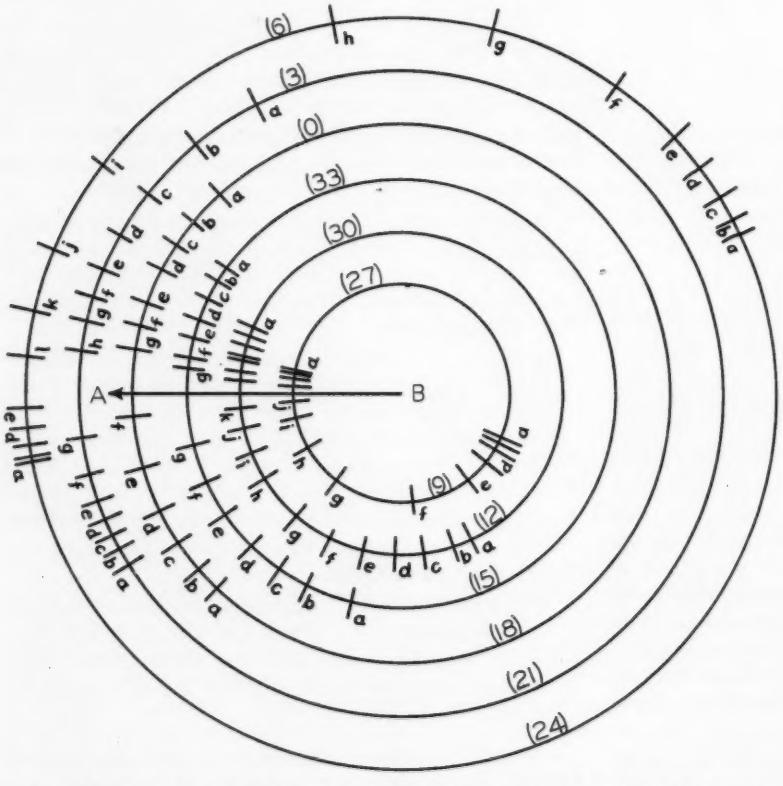

Fig. 1 Special paper with concentric circles used for recording survey data by the Ghaly method of topographic surveys

SAMPLE FIELD NOTES

Az.	(0)	(3)	(6)	(9)	(12)	(15)
a	16.3	13.7	14.8	13.8	17.3	16.8
b	14.2	13.3	13.8	12.7	16.3	16.3
c	13.3	12.9	12.7	11.7	15.6	15.2
d	12.2	12.1	11.7	10.7	14.8	14.2
e	11.2	11.2	11.2	11.3	14.1	13.2
f	10.4	10.3	10.7	10.8	13.3	12.4
g	9.5	9.5	10.5	10.6	12.6	11.4
h		9.2	10.4	10.3	11.8	10.3
i			10.4	9.8	11.1	
j			9.8	10.3	10.3	
k			9.2	9.7	9.2	

SAMPLE FIELD NOTES

	(18)	(21)	(24)	(27)	(30)	(33)
a	15.9	15.8	15.7	16.8	14.4	14.6
b	15.4	14.7	14.5	15.8	13.6	13.7
c	14.3	13.7	12.8	13.6	12.4	11.7
d	13.2	13.0	11.1	9.6	11.6	10.9
e	12.1	12.2	9.2		10.7	9.8
f	10.7	11.3			9.8	9.4
g	9.2	9.8			9.2	
h						

Fig. 2 Sample of field notes by the Ghaly method

intersecting lines, one the known radial line (azimuth) passing through the instrument man's station and the other a line of unknown azimuth passing through the sighter's station to the rodman's position. Of course the distance and direction of the sighter is determined with respect to the instrument man's station, the distance being recorded in the field book (and possibly the direction, but not necessarily) and the line of direction marked on the sighter's sheet. Using this method eliminates the need of the instrument man concerning himself with the direction of the level shot from his position; so long as he keeps the rodman on the given radial line, the sighter will do all the locating with a minimum of effort.

It is doubtful that the actual time to make a survey by Ghaly's method has been compared to that taken by standard methods, with both area and surveying party being the same. Possibly Ghaly's method requires less time because of the minimum amount of adjustment of the instruments.

The real time-saving comes in making up the actual contour map in the office. Referring to Fig. 3 and imagining that the contour lines do not exist, we can see the practical side of this system. Deciding on the scale — for any scale can be used—locating position *A* (instrument man's station) and then drawing a radial line out in the general direction of *B* (sighter's station), or using the exact location as given in the field book to locate *B*, we have our initial starting point. With position *B* established on the mapping paper, the sighter's sheet is slipped under so that line *A-B* on his sheet coincides with *A-B* on the mapping paper and the center of the concentric circles directly under the *B* position shown on the map. From here on in it is simply a matter of first drawing all the radial lines from position *A*, as recorded in the field book; then, using the properly identified circle, mark off all the stations according to those indicated on the circle, projecting a line from *B* through the mark (Fig. 1) on the circle until it intersects the proper radial line (Fig. 3). As an example, take radial line 3 (30 deg) and the corresponding circle (since half the radial lines are on the northern half of the circles, the remaining radial lines can be indicated on the same circles providing there is sufficient room; or separate circles can be used for each radial line) and mark *a* on the circle; project a line through *B* and *a* until it intersects radial line 3; from the field notes (Fig. 2) the elevation is recorded for this station on the map. The process is repeated until all stations and elevations are indicated; contour lines are then worked out as they would be in any other contour map.

It should be noted that it is advantageous to have two sight positions about 90 deg apart from each other, thus minimizing the grouping of sight lines close together. Fig. 3 shows what happens when this is not done. In other words, the second sight station would provide a more accurate location of the rodman's position on radial lines 6, 9, 24 and 27 than when located from position B. Thus the sighter, in the example illustrated, while at position B would mark only the position of the rodman on radial lines 0, 3, 12, 15, 18, 21, 30 and 33. He would then set up a new position approximately 90 deg from station B and locate the rodman on the remaining radial lines, 6, 9, 24 and 27. Better distribution of sight lines are maintained making the plotting of contour lines that much easier.

It is felt that Ghaly's method offers exceptional possibilities and lends itself easily in setting up field notes and concentric sight circles to suit the instrument man making the survey.

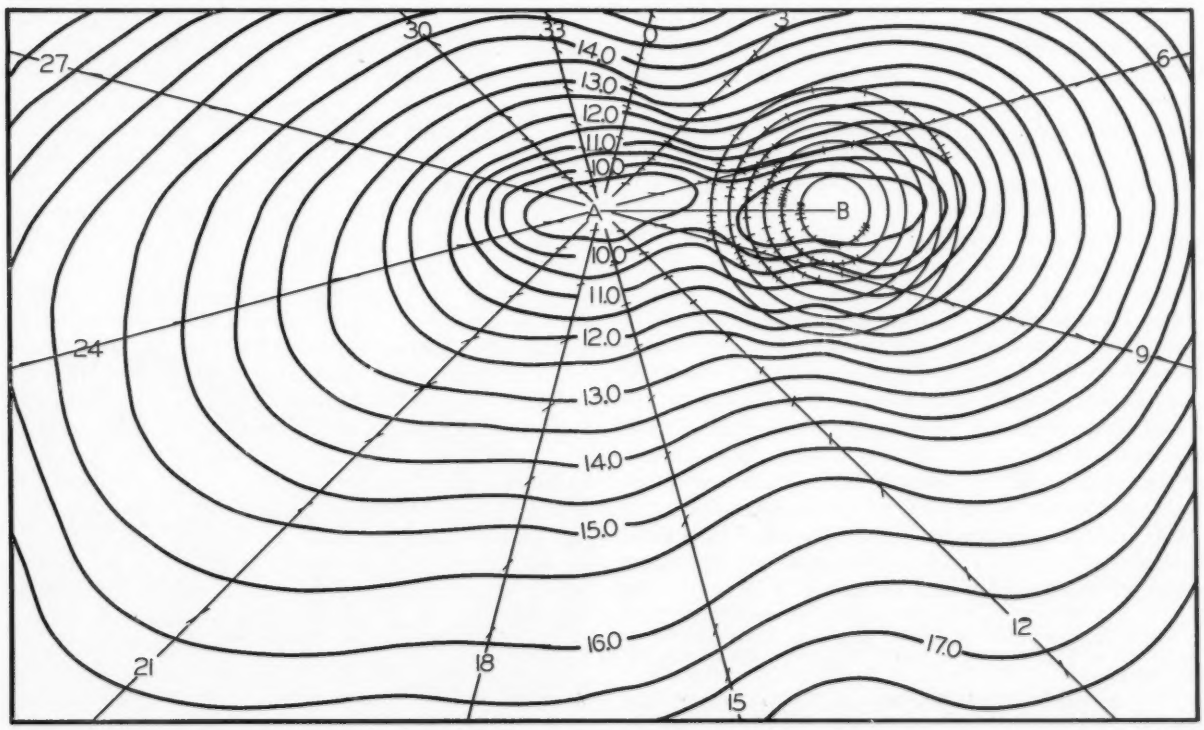

Fig. 3 Contour map made up in accord with the Ghaly method

Farm Buildings Animals Can Pay For

Harry L. Garver and Wallace Ashby

Production, management, and economic considerations, combined with sound engineering practices, are essential in arriving at correct answer to questions implied in this subject.

FROM a farm business viewpoint perhaps we should say that animals cannot afford to pay more for buildings than the lowest cost at which the essential services they contribute can be provided. We need more information as to what these essential services are and the lowest cost at which they can be obtained. Research is helping to answer these questions.

Of course, the more favorable the price-cost ratio, the less the farmer will be hurt by investing too much or by getting fewer services than he might get from a given investment. The "cost-price squeeze" has hit most livestock enterprises and the average annual consumption of milk per person has dropped from 752 to 689 pounds in 10 years. If there was a question about buildings animals could pay for 10 years ago, there is a bigger one now.

Good animals and good management can pay more for housing than poorer ones. Michigan gives a good example. With average cows and usual practices, the annual labor income of a one-man dairy farm was $1,553; with good cows and improved practices, $5,733. With either ordinary or improved practices, good cows more than doubled the labor income. A new USDA bulletin. "Cull the Cow that Culls your Profits," propounds the same philosophy that brought about the trap nest for hens—"Get rid of the boarders." That most certainly is the place to begin, but it still leaves the problem of finding out what the needed services are and how to supply them at the lowest possible cost.

What sort of environment enables the animal to grow and produce efficiently? The Agricultural Engineering Research Branch (USDA) is cooperating with other branches of the Agricultural Research Service and with the Missouri and California agricultural experiment stations on these questions.

Briefly, studies in the laboratory at Columbia, Mo., showed that slowly lowering stable temperature from 50 to 4 F had little effect on milk production of Holstein or Brown Swiss cows in stalls. As the stable temperature was lowered, the cows ate more roughage, grew longer, thicker hair, produced more body heat, and gave off less moisture to the air. However, Jersey production fell off considerably under these conditions. As temperatures rose above 80 F, both Holstein and Jersey milk production and feed consumption fell off rapidly. The cows had much more difficulty in adjusting to high than to low temperatures.

How about poultry? Our investigations of the effect of environmental conditions on health, growth, and production, while far from complete, seem to show certain facts. Maximum production is not confined to a pin-pointed set of conditions. Maryland-grown Rhode Island Red hens under observation in our calorimeters at Beltsville at the best gave 75 to 80 percent egg production at about 55 F and 75 percent relative humidity, but they produced 70 percent and over all the way from 40 to 75 F under otherwise similar conditions. Production does, however, appear to drop off fairly rapidly below freezing and above 80 F, and feed consumption per pound of eggs was least at 55 F.

During the past spring we ran two groups of chicks through our calorimeters. A partial report of the results was given at the ASAE annual meeting in June, 1954. We repeat some of it here and bring it up to date.

Seventy New Hampshire day-old chicks were placed under each brooder. The two brooders were as nearly identical as was humanly possible to make them. The calorimeter temperatures (corresponding to room temperatures) were maintained at 67 F and 86 F throughout the 13 weeks of test. Mortality was two chicks in the cool chamber and one in the warm chamber. The chicks in the warm chamber outgrew those in the cool chamber by about 17 percent during the first three weeks. For the next two weeks they maintained about the same difference in body weight. By the middle of the sixth week the two groups weighed the same. From then on, the birds in the cool chamber grew increasingly faster than those in the warm chamber.

At the end of the thirteenth week the birds were slaughtered and notes made of thyroid, heart, head, comb, and sex-organ development. The birds in the cool room outweighed those in the warm room by over 10 percent.

On the other hand, development of sex organs was more rapid in the warm box. The roosters began to crow at 7 to 8 weeks. The average weight of gonads in the warm box was nearly four times that in the cool box.

We can easily draw wrong conclusions from too few samples. However, should subsequent runs produce similar results, we would very likely advocate the design of a warmer house in which to grow birds for eggs or breeding stock than we would for broilers. Further tests may suggest a warm room in which to start the brooding and a cooler space in which to finish it.

Work in cooperation with California showed that the average daily gain of swine accustomed to a warm climate appears to reach a peak at approximately 60 F for heavy fattening hogs and at 70 F for 100-lb pigs. Rate of gain fell off rapidly at temperatures either above or below those levels.

As a result of these studies we now believe it is more important to protect animals and birds from high than from low temperatures. What can be done to make animals more comfortable on hot days? Shade them from direct sunshine and protect against radiation from bare earth and other hot surfaces. Large trees in green pastures provide good shade. Allow free air movement, and on very hot days provide sprays or wallows of clean water. Remember

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that cows, swine, and poultry do not sweat. However, some degree of judgment should be exercised in cooling animals by evaporation of moisture from their body surface. Perhaps we should have some form of instrument that would indicate the rate of evaporation in combination with air temperature.

Since there is direct relationship between the design and layout of an animal shelter and the labor requirements, consideration should be given to all factors that reduce time and effort for the man who cares for livestock.

In the case of dairy cows a combination of measures such as planned arrangement of buildings, pipe-line milking in elevated stalls, ground-level storage of feed and bedding, separation of dry and milking cows, self-feeders for hay and silage, hard-surfaced lots, tools conveniently located, and good management practices can reduce chore labor from 100 or more to 70 or fewer man-hours per cow per year.

Finally, what is a reasonable amount for a farmer to invest in buildings and what type of buildings will provide the right environment and layout most economically? We are not going to try to answer this directly, but have some information that may be interesting.

In 1949 there were 1,700,000 farms in the United States that kept only one or two cows. These farms produce little milk for sale, but the cows pay returns in family living and an occasional calf. Another 1,300,000 farms kept three to nine cows each. They represent about one-third of all the milk cows in the country, but the production *per farm* is so small it is hard to pay for buildings and equipment to meet quality milk requirements. What can these farmers do to keep building costs down? One solution would be either enlarge their operation to milk at least 15 cows, or to keep only one or two for home use.

What about the 660,000 farms with ten or more milk cows that supply two-thirds of the commercial milk supply? How much are the cows on such farms now paying for shelter. A partial answer may be found in the report of a study of economic and functional characteristics of farm dairy buildings in the Chicago and St. Louis milksheds of Illinois. It is reported in Illinois Agricultural Experiment Station Bulletin No. 570 and covers 350 dairy farms for which farm accounts were available. This study was made jointly by the U.S. Department of Agriculture and the Illinois Agricultural Experiment Station.

Grade A milk was produced on 241 farms, grade B on 60, unclassified on 41, and butterfat on 8 farms. All but ten sold bulk milk. When the dairy enterprise was charged with feed at market prices and labor, depreciation and interest at going rates, 52 percent of the farms were making a profit while 48 percent were losing money. Most farms had a substantial cash income even though the dairy enterprise showed a paper loss. Such cash balances, however, were due not to efficiency of the dairy enterprise, but to efficiency of crop and feed production and to use of a large amount of unpaid family labor.

Fig. 1 Pole barn used for bedded area of loose-housing system in southwest Illinois. Note bedding stored at rear. (Picture by courtesy of Doane Agricultural Service)

We can assume that the lack of dairy profits was due in part to the character of the buildings. Most of the barns studied were from 40 to 70 years old and were built when the farms produced grain and meat animals. While the structural condition of 95 percent was good or fair, few had been remodeled into efficient dairy barns.

A score card was used in rating the functional characteristics of each dairy building. Ratings were from 1 to 5, the rating of 1 being the best. More than half of the farms were rated below 2 on the following items: stall size, mangers and bunks, alleys, gutters, water protection, water adequacy, external layout, cleaning operations, clean cows and cooling facilities for milk. Thirty percent of the farms had too much building space while another 33 percent needed space. Lack of flexibility was found to be a serious fault of these buildings.

The average appraised (depreciated) value of these buildings in 1947 was about $285 per producing cow. Annual building cost was $38, and since the average dairy enterprise was just breaking even, the amount available to pay building costs also averaged $38 per cow. Capitalizing the $38 annual charge at 8 percent, a farmer might expect his cows to pay for new dairy buildings at not more than $475 per milking cow, assuming that half the animals to be housed were producers and the rest heifers and calves.

Well, what kind of a barn can you build for that price? Data collected by Thayer Cleaver showed that the cost of a new stall barn with milkhouse, equipment and young stock space was about as follows in Illinois in 1952:

10 to 15 stalls—$700 per producing cow
30 to 40 stalls—$600 " " "
50 to 60 stalls—$500 " " "

This assumed that all materials were purchased and all labor hired.

Other information collected by Cleaver indicated that a complete loose-housing setup suitable for a 25-cow herd could be built in Illinois in 1952 for $325 to $350 per cow.

Marketing Research Report No. 64 reports a study made by the U.S. Department of Agriculture under contract with the Doane Agricultural Service where the cost of a 25-cow loose-housing system with pole barn, two elevated milking stalls, a preparation stall, a pipe-line milker and spray milk cooler was $247 per cow. This included a 24 x 60 x 6-ft bunker silo. Part of the space was provided in an old barn appraised at 30¢ per sq ft. With some rearrangement and additional milkhouse equipment, the capacity could be stepped up to 40 cows and the cost lowered to less than $200 per cow. This would allow 35 to 40 sq ft of bedded area, and 55 to 60 sq ft of paved lot per milking cow, but little space for young stock.

We are puzzled by the wide difference in recommendations for square feet of bedded area and pounds of bedding per cow for loose-housing systems. The 35 to 40 sq ft of bedded area and 3 lb of bedding per day, found ample in

southwestern Illinois, is only a little more than half the space and one-third the bedding recommended by some northern states. The growing season at Greenville, Ill., is 190 days; at New Brunswick, N. J., for example, 181 days. The average January temperature at Greenville is 30 F; at New Brunswick, 31.5 F. Hours of winter sunshine per day at Greenville are 4.75, at New Brunswick 5.0. Under these conditions the difference in space and bedding requirements must be due largely to building arrangement and the management practices of the operator. Ithaca, N. Y., of course, is a different story, with a growing season of 158 days, an average January temperature of 25.4 F, and 3 hr of winter sunshine daily. Here climatic differences are important.

No doubt some of the difference in space and bedding used per cow in the loose-housing system lies in arrangement and the management practices of the operator.

Returning to the survey of 350 Illinois barns, note the distribution of annual costs shown in the following tabulation:

DISTRIBUTION OF ANNUAL DAIRY COSTS PER FARM

	Cash costs		Total costs	
	Dollars	Percent	Dollars	Percent
Buildings	147	8	720	10
Equipment	75	4	151	2
Stock	158	8	310	4
Feed	1252	65	5139	70
Labor	288	15	1009	14
Total	1920	100	7329	100

Annual feed costs were seven times as large as annual building costs. Buildings can earn at least part of their cost by savings on feed.

Labor costs were 40 percent higher than building costs. With modern design and equipment, labor could be cut about in half and thus make a substantial addition to net income, or at least give the farm family more time for other things.

In conclusion, we have tried to point out the importance of production, management, and economic considerations related to buildings that animals can pay for, as well as to give data bearing on the engineering problems. We should also call attention to sanitation and safety for animals and persons. We are aware that we have said little about buildings for poultry or swine. There is much less research information available on those buildings than on buildings for dairy animals. Poultry and swine housing are subjects on which more research is especially needed.

Fig. 2 Temperature zones based on average January temperatures, in degrees Fahrenheit (light-faced figures), adjusted for relative humidity. (Data from U.S. Weather Bureau)

Pole Pier Foundation

(Continued from page 20)

depth of 10 to 12 in and saved for finish grading. The only available tractor-powered posthole digger cut a hole 12 in in diameter and 3 ft deep. The holes were extended to 3½ or 4 ft with hand tools.

Posts were aligned on the outside edge to assure a straight exterior wall. The sill girts were leveled and nailed at the desired height. In some cases it was necessary either to trim the post or shim under the girt to get a straight wall. Tops of the posts were cut off if they projected above the girts. The sill was attached to the girts. The tongue was removed from the top centermatched plank to obtain a tight fit at the sill. Then the curtain wall was built from the top down.

The most careful procedure was necessary to lay out the building. First it had to be laid out to full size and checked for accuracy and 90-deg corners. Then it was necessary to locate the center point for each posthole. The string for aligning the posts was set 1⅜ in in from the building line, or the width of the girt, on each side and end.

This pole pier foundation is an adaptation derived from several common methods of construction as found in pole-and-plank surface silos, pole-frame buildings, low-cost wood-floored buildings, and framing under loading docks and platforms. We do not know of its use heretofore as a base for clear-span, utility-type structures.

Manpower Studies

POOR vocational guidance keeps many young people from taking advantage of numerous opportunities to become skilled workers and technicians, the National Manpower Council (Graduate School of Business, Columbia University, New York 27, N. Y.) declared in announcing the publication on December 20 of its latest study on skilled manpower entitled "A Policy for Skilled Manpower." It has analyzed such critical manpower problems as student deferment and the supply and utilization of scientific and professional manpower. Among other aspects of the problem, the study considers how skilled workers are trained, their role in the armed forces, and the effect of secondary education and vocational guidance on the nation's future supply of skilled manpower.

Fig. 3 Average hours of sunshine daily during winter (December, January and February). (Data from U.S. Weather Bureau)

Irrigation Guide for North Central States

Keith H. Beauchamp
Member ASAE

Development of a Document Setting Forth Basic Design Criteria for Irrigation Water Application

MANY farmers in the North Central states are purchasing irrigation systems with the idea of using them for crop insurance; that is, for the purpose of applying some water to save the crop during a drought. How often have you heard a farmer say, when a crop begins to show signs of lack of water, "If I could just put on a couple of inches of water right now!"

Designing and operating an irrigation system, based only on this viewpoint, will certainly limit the successful use of irrigation systems in the humid area. Effective, profitable irrigation is more than just putting on water when the effects of the drought can be seen in the plant. For irrigation to pay year in and year out, on many soils and with many crops, it is necessary to increase fertilization and plant population and then apply water in accordance with the needs of the crops and capacities of the soils. To do this effectively, the combined knowledge of the soil scientist, agronomist, and engineer is required. The necessary data from each of these technical fields can be assembled in an irrigation guide.

The irrigation guide then becomes a document that sets forth the basic design criteria for all methods of irrigation water-application recommended for the soils, crops, climate and water supply of the area under consideration. Such a guide should include a tabulation of all the soils and applicable crops that will influence the determination of design criteria. The irrigation guide will thus contain answers to the questions that are of vital interest to the designer, such as: How deep should a soil be moistened, how much water should be applied at each irrigation, when should crops be irrigated, how fast can water be applied, and how long will one application take? When a designer has an answer to these questions, he is then able to design a system for conservation irrigation. Conservation irrigation simply means applying the needed amount of irrigation water without waste or damage to the land, and maintaining soil productivity.

Irrigation guides are designed primarily for the use of technicians, including Soil Conservation Service, extension service, college and private engineers. In the areas where sprinkler irrigation is practiced, the guide should be made available to the sprinkler equipment people, in order to obtain better uniformity of design among all concerned. The Ohio irrigation guide includes the following statement: "The guide will be used by the Soil Conservation Service and Agricultural Extension Service in Ohio in assisting farmers with the practice of conservation irrigation and for resident teaching at Ohio State University. It is recommended for use by irrigation equipment manufacturers, distributors, and dealers in the design of sprinkler irrigation systems in Ohio. Irrigation guides are technical documents and are not intended to be used by the farmer."

The irrigation guide must be designed to fit local soils, crops, climate and water factors. This fact must be kept in mind in determining the size of area for which the guide will furnish design criteria. The primary factor controlling the size of the area to be covered by a guide should be the similarity in design criteria based on soil, topography and climate. All combinations of local conditions should be covered in the document, so that the irrigation planners will not be faced with conditions for which there are no irrigation recommendations. Normally, the smallest area included in an irrigation guide will be the individual soil conservation district; the largest could be an entire state. Irrigation guides have been prepared on a state basis in Ohio, Michigan, Illinois and Indiana.

In the states mentioned above, irrigation guides have been developed cooperatively by the Soil Conservation Service, extension service, experiment stations and Agricultural Research Service. Engineers, soil scientists, agronomists, plant materials people, and others from these agencies gathered around the table and went down the list—soil group by soil group, and crop by crop—and came up with the best recommendations they could formulate for the required design criteria. A surprising amount of valuable and applicable information and data can be dug up by a group such as this.

We realize that not all of the material that must be included in the guides can be based on firm conclusions at present, because of a lack of sufficient research and experience in irrigation design and operation in the North Central states. The amount of irrigation research is rapidly increasing in this area, but the demand by farmers for adequate irrigation design also is increasing rapidly.

By studying available research results within a state, adapting research work from other areas of a similar soil, climate and crop condition, making use of knowledge gained through local experience, and with sound thinking, a practical irrigation guide can be developed for a given area. Design criteria resulting from the pooling of information and data from a great many technicians is much sounder than criteria which any one individual, charged with the design of an irrigation system, would be able to develop.

In all probability, most of the irrigation that will be practiced in the North Central states will be done by sprinklers. For this reason, and because of the limitation on time, the remainder of this presentation will be devoted to guides for sprinkler irrigation. There are, however, numerous areas where gravity irrigation should and will be practiced. Irrigation guides covering gravity irrigation should be developed for those areas.

The irrigation guide should be developed along the theory of limiting the moisture deficiency in the soil and applying water in accordance with the soil's capacity and ability to absorb water. It is neither desirable nor practical to allow the crops to exhaust all of the available soil moisture in the root zone before beginning to replace the moisture by irrigation. If this is permitted, the plants will wilt and growth will stop. The result would be serious damage to the crop, if not complete crop failure. Therefore, the

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Soil and Water Division.

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sprinkler system should be so designed that water can be applied to the entire field before growth stops or is seriously retarded. To do this, it is necessary to select a minimum moisture level at which irrigation should be started as well as the lowest level that can be permitted for the last day's irrigation on the first round. (Refer to Fig. 1.)

There are substantial data that show a marked reduction in crop growth when the available moisture is depleted to the 15 to 20 percent level. It would seem then that this 15 to 20 percent level would be a good lower limit of moisture depletion for design purposes.

The moisture level at which to start irrigation must be determined from a practical standpoint, however. A farmer is generally reluctant to start irrigation at too high a moisture level, because the soil just doesn't seem dry enough to warrant the trouble of setting up the sprinklers. As this starting level is lowered and becomes closer to the lower moisture limit, the allowable time to cover the field is lessened and the cost of the system is increased correspondingly. After considering these factors, it appears that the logical level of available moisture at which to start irrigation would be 55 to 60 percent.

Most of the irrigation guides in the North Central states are based on starting irrigation at the 60 percent level and preventing the moisture level from dropping below 20 percent. With 60 percent as a starting level, an amount of water equal to 40 percent of the available moisture would be applied over the entire field at each irrigation. With this approach, the moisture level at the end of the field opposite from the start of irrigation is never above the 60 percent level during a prolonged drought.

Since benefits of irrigation appear to be greater at higher moisture levels than at moderate or low levels, recent thinking is to maintain a high moisture level for the entire field by applying varying amounts of water as the sprinklers are moved across the field during the first cycle of irrigation. One method of doing this in line with the 60-20 standard is to apply an amount equal to 40 percent of the available moisture over the first one-third of the field, increase this amount to 55 percent for the second third and to 70 percent for the last third of the field. If it is necessary to repeat the irrigation immediately, the 40 percent amount would be used throughout the second cycle, thus providing a high moisture level over the entire field for the length of the drought period.

The irrigation guide must also answer the questions of depth to irrigate and peak daily use of different crops. Recommendations on maximum application rate and waterholding capacity of the various soils that might be irrigated should be made. All of the required information making up the design criteria should be set down in some form that can be readily used by the irrigation planner. One suggested method of recording this data is shown in Fig. 2.

An explanation of the columns in Fig. 2 follows:

Column 1: National Code used by the Soil Conservation Service for the different soils listed in column 2.

Column 2: Soil Group. Soil types that are similar with regard to their behavior under irrigation have been grouped; the number for each group is shown. The group numbers of the soils correspondingly shown in columns 1 and 3 are listed in this column.

Column 3: Description of Soil Group. This is a description of the soils referred to in columns 1 and 2, giving color, profile drainage, texture, permeability and reference to heavy layers of the soil profile.

Column 4: Soil Depth. The soil is broken down into specific sections, measured in inches of soil profile for which moisture data are given in column 5.

Column 5: Available Moisture-Holding Capacity of the Soil. This available capacity is the soil-moisture content between the wilting point and field capacity, expressed in inches of water per inch of each soil depth given in column 4.

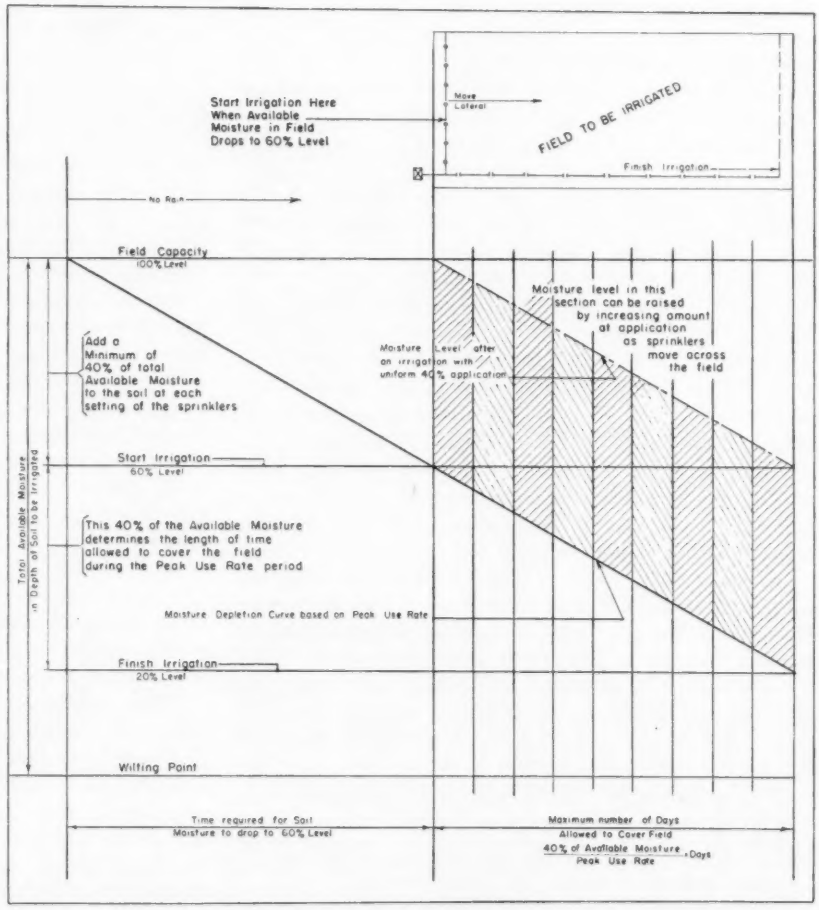
Start Irrigation Here When Available Moisture in Field Drops to 60% Level
Move Lateral
FIELD TO BE IRRIGATED
Finish Irrigation
No Rain
Field Capacity 100% Level
Moisture level in this section can be raised by increasing amount of application as sprinklers move across the field
Add a Minimum of 40% of total Available Moisture to the soil at each setting of the sprinklers
Moisture Level after an irrigation with uniform 40% application
Start Irrigation 60% Level
This 40% of the Available Moisture determines the length of time allowed to cover the field during the Peak Use Rate period
Total Available Moisture in Depth of Soil to be Irrigated
Moisture Depletion Curve based on Peak Use Rate
Finish Irrigation 20% Level
Wilting Point
Time required for Soil Moisture to drop to 60% Level
Maximum number of Days Allowed to Cover Field
40% of Available Moisture, Days
Peak Use Rate

Fig. 1 Limiting moisture depletion of the soil

SOILS							CROPS			IRRIGATION SPECIFICATIONS									
											FOR FIRST CYCLE OF IRRIGATION									
											Use in First 1/3 of Area			Use in middle 1/3 of Area			Use in Last 1/3 of Area			
											40% Available Moisture			55% Available Moisture			70% Available Moisture			
1 National Code	2 Soil Group	3 Description of Soil Group: color, texture, permeability	4 Soil Depth (inches)	5 Available moisture capacity (inches per inch of soil depth)	6 Maximum intake rate (in./hr.) Bare	6 Maximum intake rate (in./hr.) Cover	7 Crops adapted to soil group	8 Depth of soil to be irrigated (inches)	9 Peak moisture use rate (in./day)	10 Available moisture in soil depth to be irrigated (inches)	11 Water to be applied at each irrigation based on 70% Eff. (inches)	12 Application time based on maximum intake rate (Hours) Bare	12 Application time based on maximum intake rate (Hours) Cover	13 Water to be applied at each irrigation based on 70% Eff. (inches)	14 Application time based on maximum intake rate (Hours) Bare	14 Application time based on maximum intake rate (Hours) Cover	15 Water to be applied at each irrigation based on 70% Eff. (inches)	16 Application time based on maximum intake rate (Hours) Bare	16 Application time based on maximum intake rate (Hours) Cover	17 Maximum time to cover irrigated area based on the peak use rate (Days)
2S46	42,43	Light-colored sandy soils with moderately coarse-textured subsoils that are medium to moderately rapid permeability	0-9 9-18 18-30 30-42	.10 .08 .11 .06	0.8	1.0	Truck crops Group 1	18	0.20	1.6	.9	1.1	.9	1.3	1.6	1.3	1.6	2.0	1.6	3
							Group 2	24	0.20	2.3	1.3	1.6	1.3	1.8	2.3	1.8	2.3	2.9	2.3	5
							Group 3	30	0.20	2.9	1.7	2.1	1.7	2.3	2.9	2.3	2.9	3.6	2.9	6
							Corn	36	0.30	3.3	1.9	2.4	1.9	2.6	3.3	2.6	3.3	4.1	3.3	4
							Potatoes	18	0.25	1.6	.9	1.1	.9	1.3	1.6	1.3	1.6	2.0	1.6	3
							Alfalfa	36	0.30	3.3	1.9	2.4	1.9	2.6	3.3	2.6	3.3	4.1	3.3	4
							Grass-legume forage	30	0.30	2.9	1.7	2.1	1.7	2.3	2.9	2.3	2.9	3.6	2.9	4
							Fruit trees	48	0.25	4.0	2.3	2.9	2.3	3.2	4.0	3.2	4.0	5.0	4.0	6
							Strawberries	18	0.15	1.6	.9	1.1	.9	1.3	1.6	1.3	1.6	2.0	1.6	4
							Brambles	36	0.20	3.3	1.9	2.4	1.9	2.6	3.3	2.6	3.3	4.1	3.3	6
3M46D1	275	Light colored silt loam or loam. Well drained medium textured, gravelly subsoil. Moderate to moderately-rapid permeability	0-12 12-24 24-36	.18 .16 .16	0.5	1.0	Truck crops Group 1	9	0.20	1.6	.9	1.8	.9	1.3	2.6	1.3	1.6	3.2	1.6	3
							Group 2	12	0.20	2.2	1.3	2.6	1.3	1.8	3.6	1.8	2.2	4.4	2.2	5
							Group 3	18	0.20	3.1	1.8	3.6	1.8	2.5	5.0	2.5	3.1	6.2	3.1	6
							Sweet Corn	18	0.30	3.1	1.8	3.6	1.8	2.5	5.0	2.5	3.1	6.2	3.1	4
							Field Corn	24	0.30	4.1	2.3	4.6	2.3	3.2	6.4	3.2	4.1	8.2	4.1	5
							Soybeans	12	0.25	2.2	1.3	2.6	1.3	1.8	3.6	1.8	2.2	4.4	2.2	4
							Potatoes	9	0.25	1.6	.9	1.8	.9	1.3	2.6	1.3	1.6	3.2	1.6	3
							Alfalfa	24	0.30	4.1	2.3	4.6	2.3	3.2	6.4	3.2	4.1	8.2	4.1	5
							Grass-legume forage	18	0.30	3.1	1.8	3.6	1.8	2.5	5.0	2.5	3.1	6.2	3.1	4
							Strawberries	9	0.15	1.6	.9	1.8	.9	1.3	2.6	1.3	1.6	3.2	1.6	4
							Grapes	24	0.25	4.1	2.3	4.6	2.3	3.2	6.4	3.2	4.1	8.2	4.1	6
							Brambles	18	0.20	3.1	1.8	3.6	1.8	2.5	5.0	2.5	3.1	6.2	3.1	6
							Nursery seedlings	9	0.20	1.6	.9	1.8	.9	1.3	2.6	1.3	1.6	3.2	1.6	3
							Nursery transplants	12	0.20	2.2	1.3	2.6	1.3	1.8	3.6	1.8	2.2	4.4	2.2	5

* USE AMOUNTS IN COLUMNS 11 AND 12 FOR SECOND CYCLE OF IRRIGATION

Truck Crops - Group 1 (Shallow rooted)
Celery - Lettuce
Onions - Radishes
Spinach

Truck Crops - Group 2 (Medium rooted)
Beans - Cabbage
Carrots - Peas
Peppers

Truck Crops - Group 3 (Deep rooted)
Asparagus - Melons
Pumpkins - Tomatoes
Horseradish

Fig. 2 Typical irrigation guide covering soils, crops, and water factors used in the design of sprinkler irrigation systems

Column 6: Maximum Intake Rate. This is the rate of water absorption by the soil for bare and cover conditions for the period of irrigation. The bare condition refers to row crops and the like, where surface compaction and sealing from raindrop impact is noticeable. Under cover conditions, vegetation or mulch absorbs raindrop energy and there is little or no surface sealing. Sprinkler nozzles should be selected to supply water to the soil at the rate no greater than those given in this column.

Column 7: Crops. The crops shown opposite the soil group are those that are adapted to the particular soil group. It should be understood that the listing of the crops in this column does not mean that research data have proved that it is economically feasible to irrigate all of these crops on the given soil group. Research in the North Central States has not progressed to the point where we have economic data on very many crops under irrigation. When someone wants to try irrigating some of these crops, Fig. 2 will supply the crop data necessary for the design of the sprinkler system.

Column 8: Depth of Soil to be Irrigated. The figures listed in this column are the recommended depths of soil in inches in which moisture must be kept available for the plant. This depth should not be confused with the maximum root zone.

Column 9: Peak Moisture Use Rate. This is the peak water-use design rate. It represents the water used by the vegetative growth of the given area in transpiration and the building of plant tissue, the amount evaporated from adjacent soil, and the amount of precipitation intercepted on the plant, measured in inches per day for the irrigation period when the maximum amount of moisture is being extracted from the soil.

Column 10: Available Moisture in Soil Depth to be Irrigated. This is the total available moisture for soil depths shown in column 8 and calculated from water-holding capacity in column 5.

Columns 11 and 12: These two columns show the water application for the first one-third of the area to be irrigated during the first cycle of irrigation based on a moisture depletion of 40 percent. Use this water application over the entire area for the second cycle of irrigation.

Column 11: Water to be Applied at Each Irrigation (70 percent Efficiency). Values in this column are the amounts of water required to be discharged from the sprinkler nozzle to supply the necessary quantity of water to the soil based on an efficiency of application of 70 percent.

Column 12: Application Time Based on Maximum Intake Rate. This is the length of time required per sprinkler setting, based on the maximum intake rate shown in column 6, for both bare and cover conditions. Adjustment to values in column 6 to meet the irrigation time and labor factor may provide more acceptable values for column 12. However, any adjustment in column 6 should be less than the maximum rate shown. Lower rates necessitate a longer time of application.

Columns 13 and 14: These two columns show the water application for the middle one-third of the area to be irrigated during the first cycle of irrigation. The information is the same as in columns 11 and 12, except that the application is based on a 55 percent moisture depletion.

Columns 15 and 16: These two columns show the water application for the last one-third of the area to be irrigated during the first cycle of irrigation. The information is the same as in columns 11 and 12 except that the application is based on a 70 percent moisture depletion.

Column 17: Maximum Time to Cover Irrigated Area Based on the Peak Use Rate. This is the maximum number of days that can be used to cover the irrigated area and is based on the peak use rates for the crop as shown in column 9. This is also the minimum number of days, after starting irrigation, before the process needs to be repeated if no rain falls in the interim. This frequency depends upon the amount of usable moisture replaced in the soil at each irrigation and how fast the crops will use this moisture.

The following example will show how Fig. 2 can be used in the design of a sprinkler irrigation system for irrigating melons on a light-colored sandy soil (Soil Group 42):

Find Soil Group 42 in column 2 of Fig. 2. Next note in column 6 that the maximum intake rate of this soil under bare conditions is 0.8 in per hr. The bare condition is used because melons are a row crop. Referring to the bottom of the table, melons will be found under deep rooted truck crops—Group 3.

Locate Group 3 in line 3 under Crops in column 7, opposite Soil Group 42. Following line 3 to the right, it will be found, in column 8, that melons should be irrigated to a depth of 30 in on this light-colored sandy soil. In column 9, the Peak Moisture-Use Rate for design purposes is found to be 0.20 in per day. Column 10 shows the amount of available moisture-holding capacity to be 2.9 in in the top 30-in depth of soil irrigated. This is determined from columns 4 and 5. The top 0 to 9 in of this soil has a moisture-holding capacity of 0.10 in per inch of depth or a total of 0.9 in. The capacity of the 9- to 18-in layer, being .08 in per inch, will total 0.72 inch, and the 18- to 30-in layer with 0.11 in per inch will hold 1.3 in. Thus, the top 30 in will hold 2.9 in of water.

Still following the third line across the page, the amount of water to be applied over the first one-third of the field during the first cycle of irrigation is found in column 11 to be 1.7 in. If a sprinkler nozzle with an application rate of 0.8 in per hr (column 6) is used, column 12 shows that the time of application under bare conditions is 2.1 hr for the first one-third of the area. The amount of water to be applied over the middle one-third of the field is 2.3 in from column 13 and column 14 show a time of application of 2.9 hr. Column 15 and 16 show this information for the last one-third of the field to be 2.9 in of water to be applied and an application time of 3.6 hr. Column 17 shows six days as the maximum time allowed to cover the field for the period of highest water use during the growing season. If it should be necessary to repeat the irrigation immediately, use an application of 1.7 in (column 11) and a time of application of 2.1 hr (column 12) for the entire area to be irrigated.

(Continued on page 37)

Evaluation of Gully Control Structures

Neal E. Minshall
Member ASAE

A Study to Determine the Performance of Structures Under Prevailing Maintenance Conditions in Wisconsin

AN EXAMINATION of gully control structures in southwestern Wisconsin was undertaken during 1948 and 1949, in cooperation with the Wisconsin Agricultural Experiment Station, to determine how they had performed under prevailing maintenance conditions. Four counties were selected because of the diversity of structural types and the presence of sizeable areas of the principal soil types of the unglaciated area of southwestern Wisconsin. Most of the structures examined had been in operation 15 years and thus sufficient time had elapsed to permit an evaluation for adequacy of designs, construction methods, and maintenance.

The original intention was to make a detailed study of all structures to provide data on hydraulics, hydrology, design, construction, maintenance and performance factors. Lack of adequate facilities to allow for completion of the project in a reasonable time necessitated a large reduction in the scope of the investigation. The final method involved only a hurried examination of each structure unless it was in need of maintenance or repair. If repairs or maintenance were necessary an attempt was made to determine if the condition had been caused by weakness in design, construction or maintenance methods. Farmers were interviewed to determine the history of previous failures, repairs, maintenance, and an estimate of the maximum discharge. A total of 400 structures were examined, the results summarized and published as SCS-TP-116 (1)*. It is not the purpose of this paper to repeat much of the data and discussion given in this publication but rather to present some of the more common faults and state what has been or should be done to correct them. A partial tabulation of the data is shown in Table 1.

In this table partial failures include breaks in the fill, breaking off of the outlet or wingwalls, and cracking or tipping of the outlet sidewalls. Repairs were considered as replacement of all or part of the earth fill, extending collars, or building a new outlet. Maintenance represents such minor work as raising the fill, extending the cutoff, placing riprap, and clearing brush and weeds from the fill or around the inlet. The table shows that, at the time of the survey, only 10 percent were in need of repair but that about 35 percent should have some form of maintenance. The difference between the number of partial failures and those needing repairs indicates the repairs completed previous to this investigation.

The common misconception among farmers appears to be that structures should give satisfactory results for years without need for maintenance. Complete disregard for or lack of adequate maintenance is the weakest point in the gully-control program. An annual inspection of all structures should be made to see that *(a)* the area around the inlet is free from debris which might cause partial plugging of the inlet and a reduction in spillway capacity; *(b)* the fill is of sufficient height, free of brush, weeds and trees, with no evidence of burrowing animals, and no sloughs or cracks; *(c)* the outlet cutoff is not undermined and *(d)* that there is no evidence of concrete cracking or spalling.

A number of the ponds had trash, brush and logs which could become lodged in the structure and reduce the spillway capacity sufficiently to cause overtopping of the fill and result in complete failure. The elbows of several of the drop inlets were partially plugged with stumps and trash. One such condition which was called to the attention of the tenant in 1949 failed three years later when a section of log almost completely closed the inlet and caused overtopping of the fill. Because of this negligence the structure must now be classed as a complete failure even though there is no sign of a break in the concrete. A properly designed trash rack might have prevented this, but it could not function indefinitely without maintenance.

The original instructions to the farmer required that he fence out the fill to prevent cattle damage. The usual result was that fills became covered with weeds, brush and even small trees making them highly susceptible to damage from burrowing rodents. Some fills were even planted to pine or black locust. Where they were fenced out, they should have been mowed at regular intervals or controlled grazing permitted. In several cases the growth of brush around the inlet was heavy enough to seriously reduce the capacity. These early fills, usually made with teams and slip scrapers, were only 4 ft wide on top with 2 to 1 side slopes. More recent fills have been made with heavy equipment and their wider tops and flatter slopes greatly reduces the maintenance problem.

The most common causes of fill failures were insufficient collars, use of earth as outside forms, improper moisture content at time of placement, and poor compaction. A few failures may be attributed to overtopping caused by insufficient spillway capacity. These could perhaps have been

TABLE 1. NUMBER, HISTORY, AND CONDITION OF GULLY CONTROL STRUCTURES

	Past History			Present Condition			
Type of structure	Number examined	Complete failure	Partial failure	Need repairs	Need maintenance	Cutting at outlet	Cutoff undermined
Drop inlet	232	5	50	18	82	97	29
Box-inlet drop spillway	52	5	20	9	17	16	5
Flume	56	3	19	2	20	17	3
Concrete drop spillway	32	1	5	3	12	12	3
Masonry drop spillway	32	7	7	5	8	1	0
Total	404	21	101	37	139	143	40

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Soil and Water Division.

The author—NEAL E. MINSHALL—is project supervisor, Agricultural Research Service, U.S. Department of Agriculture.

*Numbers in parentheses refer to the appended bibliography.

avoided by providing a vegetated emergency spillway near one end of the dam. Some of the conduits were poured directly against the earth with no antiseep collars. There were no controls used on soil moisture or compaction methods in placing the earth fills. Present practice calls for rigid control of the fill material, including moisture content, placement in thin layers, and thorough compaction.

Some common interpretations made by engineers are that

- Toe drainage of all fills is necessary
- Undermining of the outlet cutoff constitutes a failure
- Drop-inlet barrels would flow full if the slope of the barrel was less than the hydraulic gradient regardless of the height of riser.

Only a small percentage of earth fills examined had any form of toe drainage yet very few failures could be attributed to seepage if reasonable care had been exercised in placement and compaction. A few of the fills which were mostly sand showed evidence of seepage at the first runoff. This was remedied by adding a one-foot clay blanket to the upstream face of the dam. A properly designed system of toe drains involves the expenditure of a considerable sum of money. Toe drainage should be provided when a large permanent pond is to be maintained and where seeps or springs are likely to occur at the junction of the fill material with the original bank. Toe drainage should not be necessary on the low-head drop spillways unless they fill one of the above conditions. Flumes or chutes should always be provided with an adequate system of drains as undermining the slope section appears to be their principal weakness. It is difficult to establish a definite criterion as to where toe drainage is required, but a reasonable answer might be provided by observational studies on field structures.

Much stress in recent years has been placed on specially designed outlets to prevent excessive scour. It should be noted here that none of the twenty-one complete failures can be attributed to undermining of the outlet. Scour holes developed on many of these structures in the first few years of operation, but in general have not been greatly enlarged by subsequent floods. This leads to the conclusion that, on moderately erodible soils, if sufficient cutoff is provided no other special precautions need be taken for the ordinary size of structure. In many cases a reasonable maintenance program can reduce the initial cost by making special outlets unnecessary. Outlet maintenance might consist of *(a)* extending cutoffs which have been undermined, *(b)* riprap below the apron or on the toe of the earth fill, *(c)* pile wings to reduce eddies, *(d)* or spur dams and revetments. For large drainage areas or extremely erodible soils the specially designed outlets are an absolute necessity. The structures examined were all designed to take the full discharge from the area undiminished by storage and where the peak discharge is of short duration. The tendency in more recent designs is to use the drop inlet structures as the outlet for detention reservoirs where the maximum discharge will last for several hours.

The drop inlets examined in the survey were all monolithic concrete structures with the riser and barrel having the same cross sectional area. The minimum height of riser at the University of Wisconsin in the 1934 tests was three times the diameter of the conduit (2). Several of the actual field structures had riser heights of two diameters or less. In two of these, where the height of the riser was less than

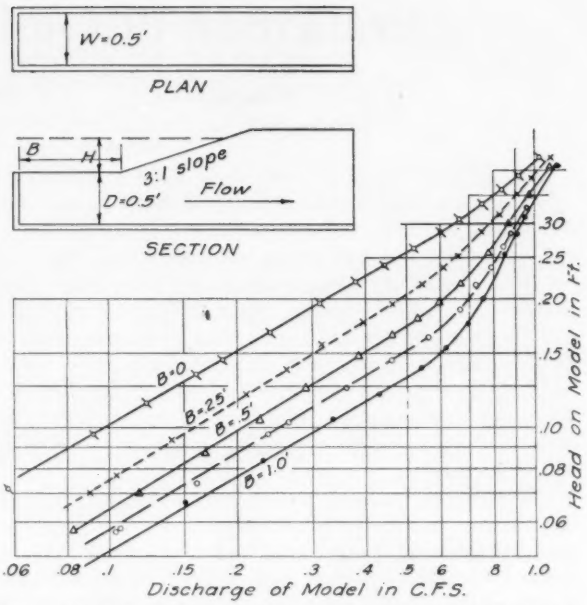

Fig. 1 Head discharge curves for box-inlet spillways without headwall. (Width and depth constant, length variable)

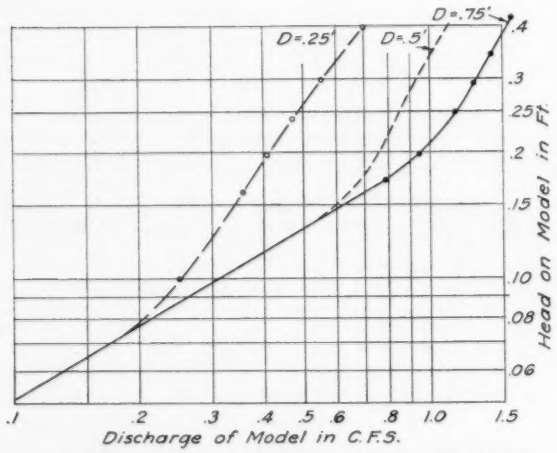

Fig. 2 Head discharge curves for box-inlet spillways without headwall. (Width and length constant, depth variable)

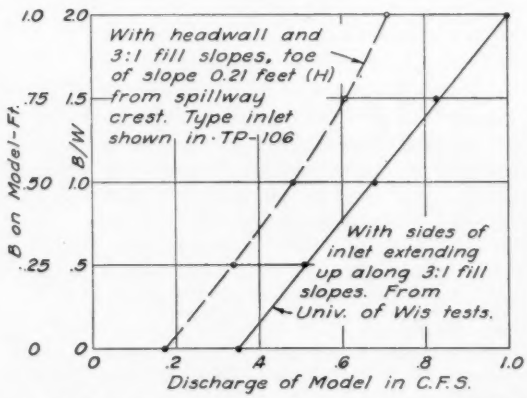
With headwall and 3:1 fill slopes, toe of slope 0.21 feet (H) from spillway crest. Type inlet shown in TP-106
With sides of inlet extending up along 3:1 fill slopes. From Univ. of Wis tests.
B on Model-Ft.
B/W
Discharge of Model in C.F.S.

Fig. 3 Head discharge curves for box-inlet spillways. (Width of model, 0.5 ft; depth of model, 0.75 ft; head over crest, 0.21 ft)

one diameter, the dam is known to have overtopped even though the barrel did not flow full. If this type of structure is to be used, studies should be made to determine the minimum height of riser necessary for the barrel to carry full capacity. Present designs call for a riser with a cross sectional area at least twice that of the barrel and tests at St. Anthony Falls show the minimum height of riser should be 4 to 5 times the diameter of the barrel.

Box Inlet Spillway

Two types of box inlet were shown SCS-TP-116 (Fig. 9). Type B was further changed in recent years by eliminating the top slab over the channel section and the cutoff under the center of the fill. The headwall length was increased to three times the design head over crest plus 3 ft and extended down below the floor of the intake section. These changes frequently resulted in a length of headwall 14 to 16 ft on each side extending from maximum water level down to the footing 3 ft below the floor of the spillway. These large headwalls contained at least 25 percent of all the concrete in a structure. The hydraulics of this type of inlet have been reported in considerable detail in SCS-TP-106 (3). It was felt that a change in the inlet design might result in a material savings. The type proposed called for the elimination of the headwall and continuing the sides of the inlet up along 3 to 1 fill slopes then using only a moderate length of cutoff under the center of the fill. This type of inlet was tested at the University of Wisconsin Hydraulics Laboratory in 1953 and the results presented in a thesis.

The results presented here are based on this thesis and subsequent check tests. The actual model was 0.5 ft wide and the lengths and depths were variable. Tests were made for depths of 0.25, 0.50, and 0.75 ft and for lengths of horizontal section of 0, 0.25, 0.50, 0.75, and 1.00 ft for each depth. The results were not analyzed for effect of H/W or B/W and the dike position was the same for all tests. The width of the channel was 5 ft so the Wc/L varied from a minimum of 2.0 for the longest box to about 10 for the short one. The actual test results are shown in Figs. 1 to 3 inclusive. From these the discharges for full-size structures can be computed from the formula $Q=Q_m N^{5/2}$, where Q_m = the discharge of the model and N is the scale ratio of the field structure to the model.

Fig. 1 shows the test results on an inlet with a depth *(D)* of 0.5 ft, width *(W)* of 0.5 ft and various lengths of the horizontal section *(B)*. For this depth and width of inlet, weir flow existed for all lengths of B up to a discharge of 0.55 to 0.60 cfs. Above this discharge the channel section appears to be the control. A discharge of 0.60 cfs can be obtained either with a B of 1.0 and $H=0.15$, or if the H is increased to 0.29 ft, the length B can be reduced to zero. With a box of given width *(W)* and depth *(D)* the same discharge capacity can be obtained by a number of combinations of head *(H)* and length *(B)*.

Fig. 2 shows the effect of depth of box on discharge for a width of box *(W)* of 0.5 ft and a length of horizontal section *(B)* of 1.0 ft. This indicates the channel section very quickly becomes the control for the shallower box. This condition might be alleviated considerably by increasing the width of the box toward the downstream end to form a trapezoidal inlet like Fig. 12 in SCS-TP-116.

Fig. 3 gives a comparison of discharges for a specific design head *(H=0.21 ft)* between the type inlet reported in SCS-TP-106 and the one tested at the University of Wisconsin. For a B/W of 2.0 in the present type the discharge of the model was 0.71 cfs. The same discharge can be passed through the new type without headwall with a reduction of B/W to 1.1. The length of the channel section would be increased by three times the sum of the design head plus freeboard. The over-all length of the two types of structures having the same discharge capacity will not be materially different. The long headwall being used on the present designs can be eliminated and replaced by a short cutoff under the center of the fill. The saving in quantities of concrete by this change in design of inlet should average about 10 percent.

Conclusions and Recommendations

1 Continued neglect of maintenance will eventually result in failures requiring extensive repairs.

2 An educational program is necessary to insure proper maintenance either in the form of a handbook or series of articles for local papers.

3 Drop inlets should be equipped with properly designed trash racks.

4 Where climate and soil conditions will permit the establishment and maintenance of a good sod, a sod flume might well replace a concrete or masonry structure on small watersheds or low overfalls. Considerable study will be necessary to determine the limitations for such sod flumes.

5 Further hydraulic studies are necessary to determine the most economical shape for the box-inlet drop spillway.

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2 Kessler, L. H., Experimental investigation of the hydraulics of drop inlets, Bulletin No. 80, University of Wisconsin Engineering Experiment Station.

3 Blaisdell, F. W. and Donnelly, C. A., Hydraulic design of the box-inlet drop spillway, SCS-TP-106, U.S. Dept. Agric., Soil Cons. Serv., July, 1951.

Irrigation Guide

(Continued from page 34)

Irrigation guides developed in this region contain the best information available for use at this time. It must be appreciated, however, that some of the data and information contained in them have not been substantiated by research and long-time experience. Irrigation here is still in its infancy. Some of the information has been obtained in other areas and adapted here. Much of it is in the form of estimates based on similar conditions. But we must have some type of working tool for design. In developing irrigation guides we are merely trying to get the best working tool possible at this time, realizing that the guide will be revised from time to time as research and additional experience and knowledge are gained.

NEWS SECTION

Nominations Announced for 1955-56 ASAE Officers

NOMINATIONS for elective officers of ASAE for 1955-56, have been reported by the Nominating Committee, K. W. Anderson (chairman), Roy Bainer, and C. K. Otis. Voting will be by letter ballot to be mailed to voting members in February. Closure of voting will be March 31. Vacancies to be filled are those anticipated by expiration of terms of office at the time of the annual meeting in June, 1955. The nominees are as follows:

NOMINEE FOR PRESIDENT

Wayne H. Worthington was born on a farm near Oskaloosa, Iowa, and grew up in Oklahoma. At 18 he graduated at the head of his class in mechanical engineering at Oklahoma A & M College.

His first employment following his graduation was as service engineer with J. I. Case Company. He was sent on an extended assignment in Russia, where he covered much of the agricultural area in European Russia, along the Trans-Siberian Railway, and south to the border of Outer Mongolia. He delivered the first gasoline tractor sold in Russia, studied advanced mathematics and theoretical mechanics at the University of Moscow, represented his company on some work in Rumania, and was detained in England as a suspected spy, while trying to return to the United States after the start of World War I. He also handled an assignment in Argentina and Uruguay before returning to work in this country.

In 1915 he joined the Aultman and Taylor Machinery Co. of Mansfield, Ohio, to design a grain thresher adapted to Russian conditions. He was advanced by stages to full charge of all engineering work for the company on grain threshers, clover hullers, and bean threshers.

In 1917 he accepted an offer to become chief engineer in the tractor division of the Electric Wheel Co. at Quincy, Ill. While there he designed a new kerosene-burning tractor engine which required no water injection, and put the company in production on the first 2-3-plow tractor weighing under 4600 pounds.

Returning to the Aultman and Taylor organization in 1920 as chief engineer, he went to Battle Creek, Mich., as chief engineer of the works there when Aultman and Taylor merged with the Advance-Rumely Co. in 1924. In 1927 he was made manager of engineering for the parent company at LaPorte, Indiana.

Following an assignment as consulting chief engineer for the Gleaner Combine Harvester Co. in 1929, he established the connection with Deere and Company which he has continued up to the present, as research engineer, assistant chief engineer and director of engineering research at the Waterloo tractor works.

In the course of this varied experience Mr. Worthington has contributed and directed the development of new and improved engineering designs and applications too numerous to mention in less than a complete biography.

A member of ASAE since 1921, he served a term as first vice-president in 1930, and for several years has been a member of the Power and Machinery Division Steering Committee. He was an ASAE Paper Award winner in 1950, was elected a Fellow in 1953, and was awarded the McCormick Medal by the Society in June, 1954.

W. H. WORTHINGTON

Other organizations in which he has active membership include the Society of Automotive Engineers, the American Statistical Association, Max Eyth Gesellschaft, Engineering Advisory Committee of the Farm Equipment Institute, Westminstet Presbyterian Church, and the John Deere Supervisors Club. He is also a 32nd-degree Mason.

NOMINEES FOR VICE-PRESIDENT

Henry J. Barre is a native of Kansas and an agricultural engineering graduate of Kansas State College in 1930. As an undergraduate he played on the varsity baseball, football and basketball teams. He went to Iowa State College as a teaching fellow and completed his graduate study there, being awarded the MS and PhD degrees in applied physics and agricultural engineering while a member of the staff. During and following this graduate study he devoted a great deal of attention to problems in grain drying.

In 1943 he was selected to head the agricultural engineering department at Purdue University. While there he was responsible for planning and initiating its professional curriculum in agricultural engineering and for subsequent development of the department and its professional curriculum to the standard required for accrediting by ECPD. During this period he also served as consultant to the Commodity Credit Corporation, on grain storage problems. In December, 1952, he accepted his present position as director of research of the Martin Steel Products Corp.

A member of the Society since 1930, he has been active in its committee work and has contributed frequently to programs of the Farm Structures and Education and Research Divisions. He served as chairman of the latter in 1946-47. He has also been active in and chairman of the Agricultural Engineering Division of the American Society for Engineering Education and is engineering representative on the agricultural board of the National Research Council. Other interests and activities include membership in the American Association for the Advancement of Science, Rotary International, and the Lutheran Church.

Gerald E. Ryerson is a native of Ohio and an agricultural engineering graduate of Ohio State University in 1928. Following his graduation he was first associated with the corn borer control program until 1931, when he transferred to erosion control work. He was assigned to the Upper Mississippi Valley Erosion Control Experiment Station for two years, then made project engineer for the first demonstration project in the

(Continued on page 40)

ASAE Meetings Calendar

January 21—IOWA-ILLINOIS SECTION, American Legion Club, 1623 15th St., Moline, Illinois

January 28—MICHIGAN SECTION, Whittier Hotel, 415 Burns Drive, Dertoit

January 28-29 — PACIFIC COAST SECTION, Fresno State College, Fresno, Calif.

February 7-9—SOUTHEAST SECTION, Brown Hotel, Louisville, Ky.

April 1 and 2—MID-CENTRAL SECTION, Hotel Robideaux, St. Joseph, Mo.

April 14 and 15—PENNSYLVANIA SECTION, Penn. State University, State College

June 12 to 15—48th ANNUAL MEETING, University of Illinois, Urbana

December 12 to 14 — WINTER MEETING, Edgewater Beach Hotel, Chicago

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Nominees for Vice-President

H. J. BARRE

G. E. RYERSON

Nominees for Councilor

GEO. M. EVELETH

ANDREW HUSTRULID

CHECK these important differences in augers for farm machines

ONE-PIECE HELICOID FLIGHTING has greater smoothness and strength. Link-Belt also builds many different shapes in various metals to meet your specific needs—cut flight, short pitch, ribbon flight, tapering, double flight to name a few.

UNIFORM PITCH — Specialized modern machinery assures accurate forming, producing uniformity in flighting curvature.

ONLY SPECIALLY SELECTED STEELS are used to meet Link-Belt's rigid specifications — assuring smooth flight surfaces.

STRAIGHTNESS is checked before shipping and extra care is taken in handling and loading.

Complete auger for this harvester-thresher is furnished by Link-Belt. Opposed flights move cut grain to center, deliver it to pick-up conveyor.

LINK-BELT gives you sound engineering plus accuracy of manufacture for top performance

WHEN you make a Link-Belt auger part of your farm machine, you can be sure of efficient operation plus long-life, low-maintenance service. Link-Belt builds augers for every purpose—gathering cut grain back of the sickle bar, conveying, elevating, spreading, feeding, mixing or digging.

Each can be engineered for your specific requirements . . . each will provide long-lasting efficiency, thanks to Link-Belt's unequalled accuracy of manufacture. Let your nearby Link-Belt sales representative point out the many important differences in augers to you. And be sure he gives you a copy of Book 2289, covering Link-Belt's regular line of conveyor screws and components.

Typical examples of Link-Belt Augers

Sectional-flight

Helicoid flight with end, plain beater

Helicoid flight auger

Opposed flights with center saw-tooth beater

Unmounted Helicoid flighting

LINK-BELT

FARM MACHINE AUGERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N. S. W.; South Africa, Springs. Representatives Throughout the World.

13,384

NEWS SECTION

(Continued from page 38)

area, at Coon Valley, Wis. Later in 1933 he was promoted to chief engineer in the Soil Conservation Service for Minnesota and Wisconsin. From 1936 to 1942 he served in Washington, D. C., as equipment engineer for the SCS. Called to active duty in 1942 in the Ordnance Department of the Army, he saw service at the Tank Automotive Center in Detroit, overseas duty in the South Pacific, and a tour in the office of the Chief of Ordnance, with promotions to the rank of major.

Returning to the Soil Conservation Service in 1946, he was designated as farm equipment research specialist and equipment engineer, and assigned responsibility as liaison officer between the Service and the farm equipment industry. Since 1947 he has carried additional responsibility for cooperative work of the Service and the industry at the Pendleton, Ore., erosion experiment station.

A member of the Society since 1934, he has been active in both the Power and Machinery and the Soil and Water Divisions. He is past-chairman of the latter division, and also a member of the Steering Committee of the former.

NOMINEES FOR COUNCILOR

George M. Eveleth was born and grew up on a farm in Western Iowa. After receiving a bachelor's degree in mechanical engineering at Iowa State College in 1935, he was employed by Cutler-Hammer, Inc., at Milwaukee. However, his farm background led him, in 1937, to become a student engineer with the International Harvester Co. in Chicago. Next he gained some production control experience with the Victor Adding Machine Co., also in Chicago. In 1942 he established a connection with the J. I. Case Co., and has continued with the company since that time in positions of progressively increasing responsibility.

His first work with the Case organization was an executive engineer at its Rock Island plant. In June, 1942, he was assigned to the Company's war work and moved to Racine as coordinator on its anti-aircraft gun mount contract, with responsibility for coordinating production of parts of the assembly in five different works. In December, 1942, he was shifted to the Company's aircraft division at Rockford as chief engineer and coordinator responsible for all engineering work of the division in five different plants.

In February, 1944, he was returned to the Rock Island Works as chief engineer directing the engineering design of tractors and implements. He has continued in that capacity up to the present.

Elected to membership in the Society in 1944, he has been active in the Iowa-Illinois Section; has served terms as vice-chairman and chairman of the Power and Machinery Division, and is a member of the Division's Steering Committee.

Andrew Hustrulid was born in Illinois but grew up on a farm in southeastern South Dakota. Following his graduation from Harriburg, S. D., high school he enrolled at the University of Minnesota. Since then he has been away from it only for brief periods.

After receiving his bachelor's degree in electrical engineering in 1931 he entered the Graduate School, and received a PhD degree in 1937, with a major in physics and a minor in mathematics.

During the last two years of his undergraduate study he also was employed in the generating department of the Northern States Power Co. While a graduate student he held teaching and research assistantships in the physics department.

After receiving his PhD degree he took an assignment in the agricultural engineering department as assistant professor in charge of work in rural electrification and agricultural physics. Promotion to associate professor came in 1943, and to professor in 1947. He served as acting head of the department in 1952-53 while A. W. Schwantes was on leave.

A member of ASAE since 1937, he has been active in the Rural Electric and the Education and Research Divisions, as well as in the Minnesota Section of which he is currently secretary-treasurer. He has presented several papers before ASAE meetings.

A registered professional agricultural engineer in Minnesota, he is also a member of the American Society for Engineering Education, American Physical Society, American Physics Teachers Association and the Minnesota Federation of Engineering Societies. He has been elected to Tau Beta Pi, Etla Kappa Nu, Sigma Xi, Gamma Alpha and Gamma Sigma Delta; and is listed in American Men of Science. His research and publications are concentrated in four fields, namely, mass spectroscopy, refrigeration and frozen foods, the heat pump and its uses, and uptake of phosphorus by plants.

NOMINEES FOR NOMINATING COMMITTEE

E. L. Barger, education manager, Ferguson Division, Massey-Harris-Ferguson, Inc.

O. C. French, head, agricultural engineering department, Cornell University.

F. P. Hanson, agricultural engineer, Caterpillar Tractor Co.

George B. Hill, agricultural engineer.

F. A. Kummer, head, agricultural engineering department, Alabama Polytechnic Institute.

F. W. Peikert, head, agricultural engineering department, Pennsylvania State University.

The ASAE Winter Meeting

AS EXPECTED, the ASAE Winter Meeting in Chicago, December 5-8, again brought together more than a thousand members and visitors for technical sessions, attention to other professional interests, numerous committee meetings, impromptu corridor conferences, and a general exchange of information and ideas in the interest of improved engineering service for agriculture. No corps of reporters was available to provide detailed news coverage of the various activities, and only a brief over-all picture with a few sidelights will be attempted here.

Word of the meeting and of some of the subjects and speakers was widely distributed by the news service wires and by radio-television coverage, both live and transcribed. Coverage started early with ASAE President G. B. Nutt, Roy Brown, Ben Auchter, Burt Cargill and Don Brown appearing Sunday afternoon, December 5, on George Menard's TV program "Farm Town, USA". G. W. McCutcheon, H. D. Bruhn, B. A. Jones, Donald Rupert, Stanley Madill, and C. F. Kelly appeared on various programs over WLS. E. G. McKibben was on Bob Elson's program over WCFL, J. S. Boyd was interviewed by Gretchen Thomas over WMAQ; and J. W. Potter, A. W. Brant and Ben Jones on the WNBQ "Town and Country" program. More than an hour of TV time and more than 5 hours of radio time were devoted to the meeting and its speakers. In addition at least 19 interviews were recorded and scheduled for broadcasting at various times up to January 8, 1955. Those interviewed for recordings included M. L. Esmay, Kenneth Harkness, Glenn O. Schwab, John E. Nicholas, H. D. Bruhn, W. F. Lytle, K. L. McFate, E. V. Collins, M. H. Lloyd, J. W. Potter, A. H. Schulz, O. E. Hays, H. A. Cloud, B. A. Jones, E. C. Schneider, E. H. Kidder, W. D. Hunnicut, and Richard Nicholas. Some other recordings may be scheduled for later transcription.

Special activities which could not be sandwiched into the three main days of technical sessions preceded and followed the meeting, to make the most of the fact that the interested agricultural engineers would be in one place, saving time and travel.

The ASAE Council met Saturday afternoon, most of Sunday, and at intervals thereafter to dispose of a variety of administrative matters.

A conference on agricultural aviation ran through Friday and Saturday preceding the meeting.

A large representation of Section, Division, and Society officers showed up for the Cabinet meeting Sunday afternoon, December 5. George B. Nutt, president of ASAE, called on Deane G. Carter and E. W. Lehmann to brief the group on plans and facilities for the 1955 Annual Meeting at Urbana. They promised air-conditioned meeting rooms and other attractions to match.

John H. Wessman reported progress on the proposed motion picture on agricultural engineering. His remarks showed that the committee has done a great deal of careful planning and investigation and had about reached the point of selecting a producer. He estimated that the picture might be completed and ready for release within another 18 months. He also indicated that qualified members of the Society would be consulted to insure accurate and adequate presentation of all phases of agricultural engineering.

R. L. Maddex, secretary of the Michigan Section, led a discussion on Section projects.

Morris H. Lloyd, chairman of the North Atlantic Section, reviewed the advantages of a proposed World Calendar with uniform months and days of the month falling uniformly each year on the same day of the week. On the basis of his report the Cabinet voted to recommend to the Council that it approve the Society's endorsement of the Calendar whenever such endorsement may be requested.

L. H. Skromme, vice-president of the Society, mentioned that should the opportunity develop, the Society would do well to lend similar support to reform of the English measure system as used in engineering work.

W. J. Ridout, Jr., reported as ASAE representative to the National Farm Electrification Conference.

Sunday evening's illustrated lecture, "As I Saw it in Pakistan," by John L. McKitrick, proved a popular feature. The Michigan Room was filled nearly to capacity with those members and guests, and their wives and families in some cases, who had arrived in time for this program.

Open meetings of the Committees on Agricultural Teacher Training, Farm Safety,

(Continued on page 42)

WHAT'S YOUR UNIVERSAL JOINT PROBLEM ?

If you're building implements like these, BLOOD BROTHERS offers great advantages

PRODUCT	BLOOD BROTHERS Universal Joints now used by leading implement manufacturers: Series	
Combines	3DR	L16S
Corn Pickers	1FR	3DR
Corn Snappers	1FR	3DR
Cotton Pickers	L6N	L16S
Diskers & Seeders	1FR	
Dusters	L6N	1FR
Elevators	K-1-C	1FR
Ensilage Blowers	K-1-C	L6N
Feed Grinders	L14N	35N
Forage Harvesters	35N	
Grain Binders	K-1-C	1FR
Hammer Mills	L14N	35N
Hay Balers	3DR	L16S
Hay Rakes	L10S	1FR
	L6N	
Manure Spreaders	L10S	1FR
Mowers	L6N	L10S
	1FR	
Post Hole Diggers	K-1-C	1FR
Potato Diggers	1FR	3DR
Rotary Weeders	K-1-C	K2R
Shredders	L14N	35N
Shellers	1FR	3DR
Snow Plows	3DR	35N
	L14N	
Sprayers	35N	3DR
	1FR	
Swathers	1FR	3DR
Tractors	K-1-C	L6N
	L6S	
Wagon Unloaders	K-1-C	1FR
	K2R	
Windrowers	1FR	3DR

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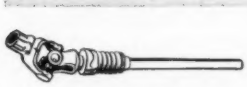
TORQUE CAPACITIES at Tractor Speeds of 550 rpm.

Series	Horsepower
K-1-C	3
K2R	3
L6S	4
L6N	5
L10S	5
1FR	10
L14S	11
3DR	15.7
L16S	19
L12N	20
L14N	30
35N	50

You can get joints alone or assembled with fixed or slip joint shafts... with or without integral safety shields, safety clutch, clamp yokes... or with the popular, salable quick-detachable yokes.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1FR Series

PTO Slip Assembly

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With Integral Safety Shields

Quick Detachable

BLOOD BROTHERS machine division

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NEWS SECTION

(Continued from page 40)

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The Chicago Section contributed materially to smooth handling of the meeting from a local arrangements standpoint. Kenneth W. Snyder, chairman of the Section, was general chairman of the Committee on Arrangements. E. R. Johnson, secretary of the Section, served as treasurer, and worked on registration, along with Mr. and Mrs. Howard C. Rutt. Arnold R. Daum, J. A. Basselman, Gerald A. Karstens, Lee H. Ford, and Mr. and Mrs. John H. Wessman maintained an active public relations office, with asistance from K. L. Pfundstein, D. P. Brown and C. E. Ball, members of the Society's Committee on Public Relations from outside of Chicago. E. B. Scott and C. N. Hinkle looked after meeting room requirements for projectors ond other facilities. Other Chicago Section members helped with various phases of the meeting.

President Nutt to Address Michigan Section

ASAE President George B. Nutt, will be one of the featured speakers on the program of the Michigan Section of the American Society of Agricultural Engineers at its meeting to be held January 28 at the Whittier Hotel, 415 Burns Drive, Detroit. Mr. Nutt will discuss the opportunities for ASAE sections and the progress that has been made by this Society activity.

At the opening (forenoon) a paper on ground water and its increasing importance to agriculture will be presented by John Ferris, district engineer, ground water branch, U.S. Geological Survey. Ervin Stahl, district manager, Layne-Northern Co. of Lansing will discuss the drilling and development of large diameter wells, and in connection with this talk a movie entitled "Deep Waters" will be shown. The third speaker will be Joe Grunewald, Electro-Vector Co., Detroit, whose subject is engineering application of electric space heating. A motion picture titled "Racing Champions" will be presented as a courtesy of the Champion Spark Plug Co.

A luncheon has been arranged for the group at noon.

The greater part of the afternoon session will be devoted to a panel discussion entitled "Tractor Transmissions Today and Tomorrow," of which D. C. Heitshu, chief engineer, John Deere Harvester Works, will be moderator. The three featured speakers on the panel will be R. C. Boyle, chief engineer, chassis section, advanced engineering group, International Harvester Co.; W. F. Shurts, director of engineering, Twin Disk Clutch Co., and M. C. Winther, vice-president in charge of engineering, Eaton Manufacturing Co. Following these three speakers, Mr. Heitshu will give a discussion-summary in which he will give particular attention to the duty of a tractor transmission. A general discussion period will follow Mr. Heitshu's summary.

President Nutt's address will complete the afternoon program.

Carl W. Hall, one of the vice-chairmen of the Section, and K. L. Pfundstein, Section chairman, will, respectively, preside at the forenoon and afternoon sessions.

The next meeting of the Section is scheduled for April 22.

Pacific Coast Section Meets January 28-29

THE Pacific Coast Section of the American Society of Agricultural Engineers will hold its 33rd annual meeting on the Shaw Avenue campus of Fresno State College at Fresno, Calif., January 28 and 29. Section chairman Ben L. Hagglund, Caterpillar Tractor Co., will preside at the opening session on the forenoon of January 28 and will open the session by introducing Dean A. R. Lang of Fresno State College, who will extend a word of welcome to those attending the meeting. The keynote address of the session will be made by A. E. Botsford, John Deere Plow Co., San Francisco. This will be followed by two technical papers, one on frost protection by forced air motion in orchards by F. A. Brooks and D. G. Rhoades, University of California, and the other on large propellers for wind machines by A. S. Leonard, also of the University of California.

Austin Armer, Spreckels Sugar Co., and chairman of the Program Committee, will preside at the afternoon session which will open with a talk on engineering principles in disk harrow design by R. W. Kramer of the Stockton Works of International Harvester Co. The second speaker is A. W. Lapins, Gobel Disc Div., Massey-Harris-Ferguson, Inc., whose subject is the relationship between soil density and drawbar pull. He will be followed by C. T. Rasmussen, chief engineer, John Deere Killefer Works, who will talk on testing of equipment in the experimental stage.

The fourth speaker at this session is L. H. Lamouria, University of California, who will talk on the mechanization of the raisin and wine grape harvesting. The freeze drying of meat is the subject to be discussed by J. C. Harper, also of the University of California.

The session will close with a business meeting and the election of officers.

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Southeast Section Program

AN INTENSIVE program has been developed for the meeting of Southeast Section of the ASAE at Louisville, Ky., Feb. 7 to 10. The meeting is to be held at the Brown Hotel, in conjunction with the annual meeting of the Association of Southern Agricultural Workers.

Twelve sessions of the Section have been scheduled, in addition to the two general meeting programs offered by the ASAW. They include a general meeting, business meeting, Section dinner, joint sessions of mutual interest to the power and machinery —soil and water groups and to the farm structures — crop processing and storage groups, and separate soil and water, rural electric, power and machinery, crop processing and storage, and farm structures sessions.

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(News continued on page 50)

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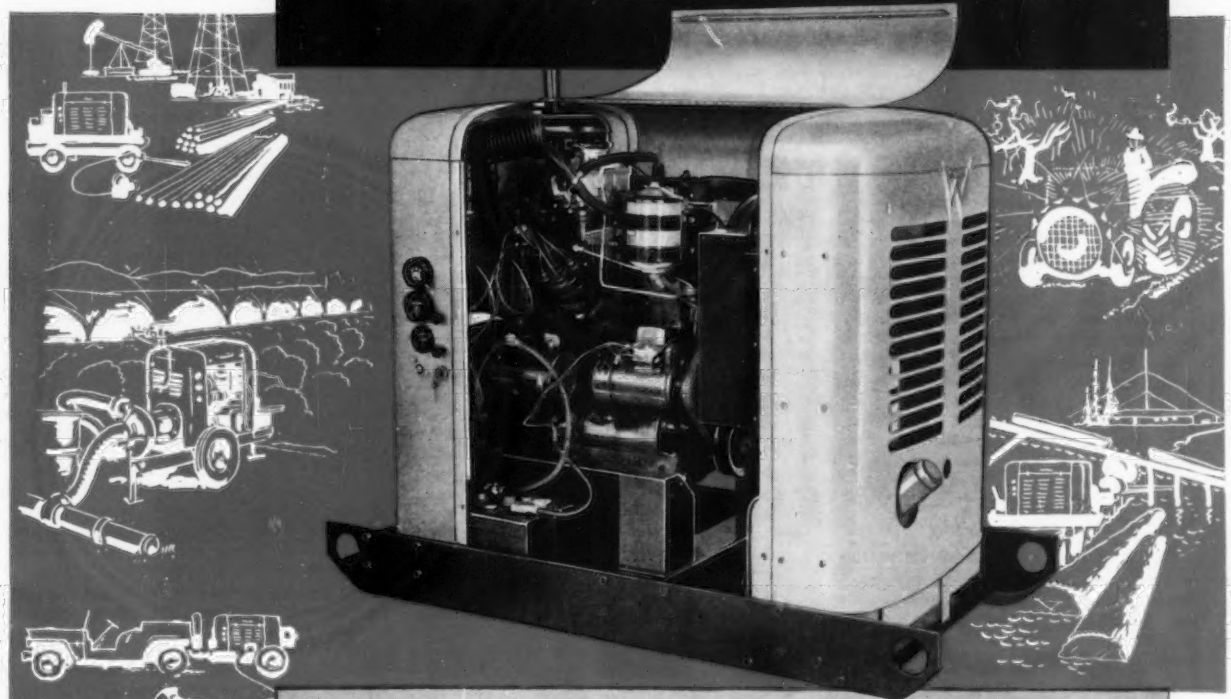

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Model	Jeep	Hurricane	Lightning	Giant Hurricane
Cylinder and Head	4 L	4 F	6 L	6 F
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Range Max. bhp	22-60	22-70	28-75	28-90
Range of Speed	1200-4000	1200-4000	1200-4000	1200-4200

Complete Specifications
Ask for 4 cyl., 6 cyl. or Power Unit Bulletins.

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WILLYS MOTORS, INC. *Industrial Engine Department*

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Willys POWER GIANT

4 and 6 CYLINDER *POWER UNITS*

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Model	Jeep	Hurricane	Lightning	Giant Hurricane
Cylinder and Head	4 L	4 F	6 L	6 F
Displacement Cu. In.	134.2	134.2	161.0	161.0
Range Max. bhp	22-60	22-70	28-75	28-90
Range of Speed	1200-4000	1200-4000	1200-4000	1200-4200

Complete Specifications
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WILLYS MOTORS, INC. *Industrial Engine Department*

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NEWS OF ASAE MEMBERS

Martin Ronning, chief engineer, power machinery division, Minneapolis-Moline Co., was recently elected chairman of the National Conference for Farm Safety, an activity of National Safety Council. His election took place at the annual meeting of the Farm Safety Conference held in conjunction with the 42nd National Safety Congress in October. The Conference is composed of agricultural leaders from the principal farm organizations, agricultural colleges, farm press and radio, U.S. Department of Agriculture, U.S. Office of Education and other organizations. At the time the Conference was organized, there was an upward trend in farm accidents, whereas today it has been proven that intensive, well-organized farm accident prevention activity produces a continuous downward trend.

MARTIN RONNING

Mr. Ronning has been an active member of the Farm Safety Conference since its early days and has played a leading role in the organization's development to a position of considerable influence in the agricultural field. His election to the chairmanship of the Conference is an honor befitting the years of unselfish service he has given in the promotion of farm safety.

Day L. Bassett is now assistant professor and assistant agricultural engineer at the State College of Washington and Washington Agricultural Experiment Station. He was formerly employed as an agricultural engineer at Othello, Wash.

Leonard D. Kimmel has accepted a position in the service department of the A. B. Farquhar Division, The Oliver Corporation. He was formerly in the employ of the New Holland Machine Co.

Leo A. Bixby, formerly vice-president of Clark Equipment Co., now operates a professional service at Niles, Mich., under the name Bixby Management & Engineering Counsel.

William D. Carpenter, formerly a design engineer of S. L. Allen Co., is presently on duty with the U.S. Army and is located at Camp Rucker, Ala.

Glenn C. Coy, is field representative of Truck-Tractor Equipment, Inc., at Columbus, Ohio.

Charles C. Edie has been released from duty with the armed services and now is employed as supervisor of service literature of the Ferguson Division of Massey-Harris-Ferguson, Inc., at Detroit, Mich.

Charles S. Floyd, previously employed as supervisor of the Southwest division of Minneapolis-Moline Co., now holds a similar position with the Midland Ford Tractor Co., Robertson, Mo.

Robert S. Freeburg has been released from duty with the U.S. Navy and is now employed as a ranch manager at Montrose, Colo.

Bernard C. Mathews, formerly vice-president of American Crop Drying Equipment Co., now owns and operates Mathews Co. at Cary, Ill.

Charles B. Seckinger, formerly employed in the production engineering section, Ford Tractor Division, Ford Motor Co., resigned to become farm machinery and engineering adviser to the Pakistan government under an FOA assignment.

Clarence J. Bergschneider, formerly employed by the Bureau of Reclamation, U.S. Department of the Interior at Denver, is now employed in the Los Angeles District Office of the Corps of Engineers, U.S. Army.

Maurice Castoriano recently resigned as engineer of International Harvester Maquinas, Brazil, to take over operation of a farm in Peru on which cotton and castor beans will be the major crop.

Robert F. McDowell has resigned his position as an agricultural engineer with the Morris Engineering Co., LaPorte, Ind., to accept a position with the firm of Vogt, Ivers, Seaman and Associates of Cincinnati. He will make his headquarters at La-Grange, Ind.

Herman S. Poorbaugh recently resigned as agricultural consultant of R. H. Sheppard Co., to accept appointment as general manager of the quarry castings and supply division of the Donegal Manufacturing Corp., Marietta, Pa. This division of the company functions as an engineering and sales outlet for steel castings used by the quarrying industry.

J. L. Reid has joined the staff of the agricultural engineering department at California State Polytechnic College. He was previously farm service engineer for Imperial Oil, Ltd., at Edmonton, Alta., Canada.

Allan W. McCulloch, until recently associated with the John W. Stang Corp., is presently district sales manager of the W. R. Ames Company and is located at Denver, Colorado.

Volney H. Smith recently accepted employment with the U.S. Soil Conservation Service and is stationed at Shenandoah, Ia.

Charles B. Peak recently joined the Deere organization as design engineer at the John Deere Harvester Works. He was formerly employed by the Detroit Harvester Co.

Charles E. Seitz, a past-president of ASAE, who recently retired as head of the department of agricultural engineering at Virginia Polytechnic Institute, has been named "Man of the Year in Southern Agriculture" by the publication *Progressive Farmer*. This is considered a most significant honor in the South.

CHARLES E. SEITZ

Mr. Seitz was honored for his pioneer work in the irrigation, drainage, and rural electrification phases of agricultural engineering. He established at VPI the first 4-year professional course in agricultural engineering east of the Mississippi River to offer a B.S. degree in that subject. In addition he directed all of the institution's extension and research work in power and machinery, rural electrification, soil and water conservation, surface and overhead irrigation, and farm structures.

On retiring as head of VPI's agricultural engineering department, Mr. Seitz did not actually go into retirement, but he was appointed a member of the newly established VPI—Blacksburg Water Authority, of which he was recently made chairman. The Authority has full responsibility for developing a new 1¼ million dollar water supply system for the college and city.

NECROLOGY

Frank N. G. Kranick, consulting agricultural engineer, Life Fellow, past-president, and member of ASAE since 1912, passed away December 13 following a heart attack. He was 74 years old.

Born at Sheboygan Falls, Wis., he attended public school at Racine, and started work with the J. I. Case Co. After two years he became a draftsman in the experimental department. He studied engineering in night school classes for six years. After ten years with Case he became associated with the Belle City Manufacturing Co., as superintendent of experiments, and designed and developed a line of threshers for the company. In 1912 he went to the Maytag Co. at Newton, Iowa, as assistant superintendent of experiments. Other early employment was with the Advance-Rumely Co., Hyatt Roller Bearing Co., and Timken Roller Bearing Co. In 1928 he returned to the J. I. Case Co. as assistant to the president on matters of engineering, sales, and research. He continued in that capacity until his retirement in 1947, after a total of 30 years of service with the Company. Following retirement he established the consulting practice which he carried on up to the time of his passing.

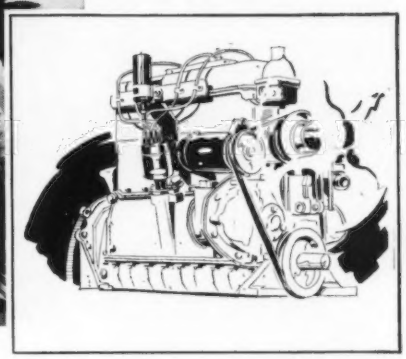
As president of ASAE in 1920 Mr. Kranick was active in planning and initiating the Society's monthly journal, AGRICULTURAL ENGINEERING, in September of that year. He was elected a Fellow in 1938 and Life Fellow effective January 1, 1948.

In connection with his work he travelled in South America in 1927, and in Germany and Russia in 1929. He revisited Germany in 1939 and maintained correspondence with a number of agricultural engineer friends there. He was also author of a text "Farm Equipment for Mechanical Power," published in 1935, and an active contributor to the farm and trade press, as well as to AGRICULTURAL ENGINEERING and meetings of the Society. In the Farm Equipment Institute he served 10 years as secretary of the Power Machinery Department, and several years as chairman of the Safety Committee.

Among other activities he was a member of the Congregational Church of Racine and of the Racine Public Library Board.

Mr. Kranick is survived by his widow and two sons, Lewis and Bruce.

A new Oliver Super "88" (*left*) was taken off the assembly line for the full series of tests that are the accepted standard of the industry. The results were startling—the tractor broke all existing records. This outstanding performance stems from engine changes based on research with Oliver's experimental engine, the XO-121 (*below*).



Oliver's Super "88" sets records

New tractor puts research findings to work: delivers outstanding power and economy

Although Oliver built the famous XO-121 experimental tractor engine as a research tool, some of its design ideas have already been put to work. And the latest Oliver production model—the Super "88"—clearly points out the striking advantages that result from higher compression ratios and high-octane fuels.

These advantages were highlighted in a recent series of tests of the new Super "88." This tractor broke all existing records for power and fuel economy. The Super "88" boasts a 7 to 1 compression ratio and delivers 30 per cent more power than the old model "88." And this outstanding performance was achieved with a noticeable gain in fuel economy. . . nearly a 10 per cent increase in horsepower-hours per gallon.

The gasolines available on farms today have reached new highs in quality and offer manufacturers an unmatched potential for great improvements in tractor power and economy.

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Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Aho, Reuben J.—Product test engineer, International Harvester Co., East Moline, Ill. (Mail) 1421 19th St.

Ayazi, Manoutchehr—Agricultural engineer, Irrigation Dept., Teheran, Iran

Becker, Abram E.—Manager, Association of Illinois Electric Cooperatives, 416 S. Seventh St., Springfield, Ill.

Brooks, Royal H.—Agricultural engineer, U.S. Salinity Laboratory, PO Box 672, Riverside, Calif.

Campbell, Lewis G.—Agricultural engineer, Central Experimental Station, Centeno, c/o Arima PO, Trinidad, B. W. I.

Chanter, W. D.—Industrial sales manager, Carolina Ford Tractor Co., PO Box 1496, Charlotte, N. C.

Childress, Robert T., Jr.—Agricultural engineer (SCS), USDA. (Mail) Box 65, Odem, Tex.

Colwill, Herbert W. — Student engineer, New Idea Div., Avco Mfg. Corp. (Mail) 229 E. Market St., Celina, Ohio

Cumming, Alexander — Agricultural development officer, Department of Agriculture. (Mail) Federal Experimental Station, Serdang, Selangor, Malaya

Davis, William E.—Engineer, Seven Springs, N. C.

Fackler, David R.—Agricultural engineer, Green Giant Co., Le Sueur, Minn. (Mail) 622 N. Main St.

Fairbank, Raymond H.—Student engineer, John Deere Harvester Works, East Moline, Ill.

Flanders, Billy H.—Farmer, Flanders Dairy, RR 1, Kite, Ga.

Gaffney, Robert L.—Sales engineer, Lennox Furnace Co., Marshalltown, Iowa. (Mail) 412 E. Church

Gardner, Basil K.—Service manager, The Stewart Co., Dallas, Tex. (Mail) 11217 Desdemona

Gates, J. B.—Manager, hydraulic products div., Thompson Products, Inc., 2196 Clarkwood Rd., Cleveland 3, Ohio

Graham, Virgil R.—Tool designer, Detroit Harvester Co., Zanesville, Ohio. (Mail) New Airport Road

Guest, Richard W.—Student in agricultural engineering, North Dakota Agricultural College. (Mail) Menoken, N. D.

Jackson, Calvin M.—Agricultural engineer (SCS), USDA. (Mail) RR 3, Maypearl, Tex.

Kesinger, Donald A.—Product engineer, International Harvester Co. (Mail) 1730 5th Ave., Moline, Ill.

Knoll, John E.—Student in agricultural engineering, North Dakota Agricultural College. (Mail) Cogswell, N. D.

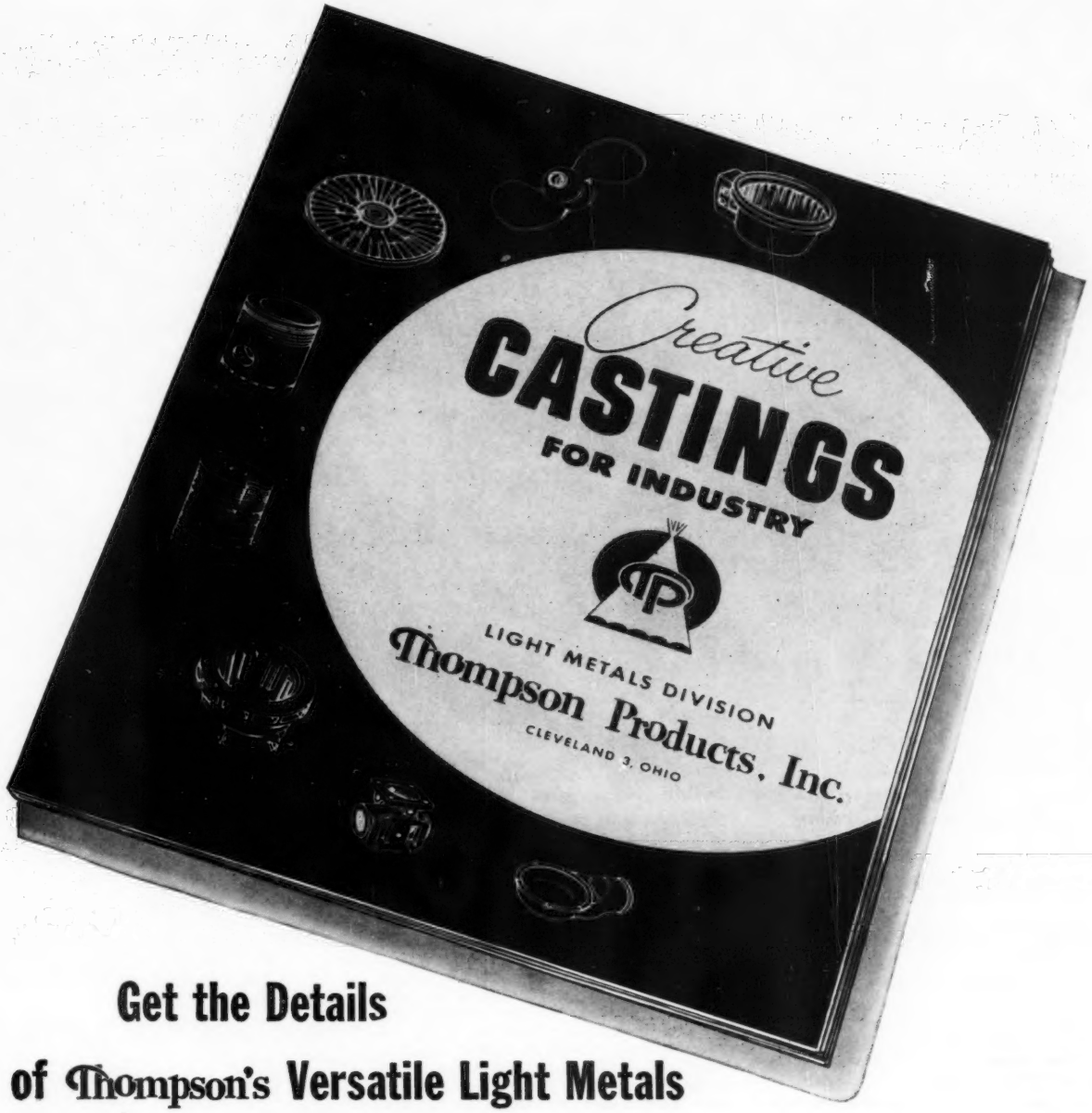
Landers, Jim—Staff representative, Goodyear Aircraft Corp., 1210 Massillon Road, Akron, Ohio

Lewellen, William H.—Engineer trainee, natural resources dept., Ohio Division of Water, Columbus, Ohio. (Mail) 38 W. Norwich Ave.

Maxedon, Leslie E.—2nd Lt., USAF, 1605th A. B. Wing, APO 406, New York, N. Y.

McClement, Ian N. — Irrigation technician and salesman, Levin & Co., Ltd., Box 167C G. P. O., Brisbane, Queensland, Australia

(Continued on page 48)



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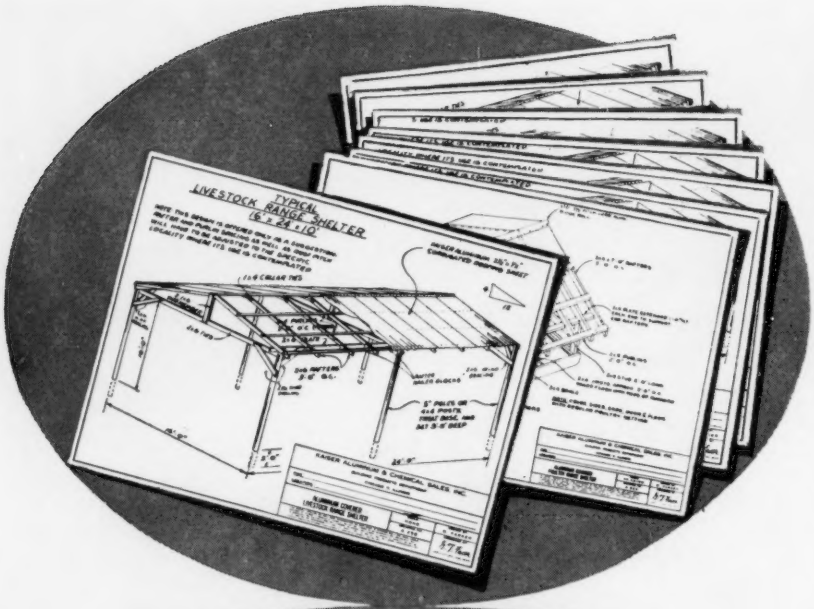

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The new Kaiser Aluminum building plans were designed by agricultural engineering specialists—most featuring low-cost pole-type construction. They provide maximum economy, consistent with maximum strength and utility.

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In addition, each plan enables farmers to take full advantage of Kaiser Aluminum Roofing—in standard sheets, or in the new 48"-wide size.

Among its many advantages are light weight with strength, reflection of hot summer sun, retention of winter warmth, long life with no red rust streaks, no rotting, no warping. And Kaiser Aluminum Roofing is economical because it requires less maintenance, is easily applied, never needs paint. Permanently attractive. It's the performance tested aluminum roofing material.

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ORGANIZATION_____

ADDRESS_____ CITY AND STATE_____

Applicants for Membership

(Continued from page 46)

McKnight, Elmer R.—President and manager, Markesan Implement Co. and LO-Boy Co., Markesan, Wis.

Oberholtz, L. E.—Vice-president of engineering, Gleaner Harvester Corp., Independence, Mo.

O'Brien, Michael—Assistant professor in agricultural engineering, University of California, Davis, Calif.

Peterson, John—Self-employed (farm structures), Harrold, S. D.

Rogers, Charles H. — Pvt., U.S. Army. (Mail) U.S. 55489225, HQ. & HQ. Btry., 3rd G.M. Bn., 2nd G.M. GP. (SSM) Fort Bliss, Tex.

Roller, Warren L.—Instructor in agricultural engineering and USDA agent, Purdue University, Lafayette, Ind.

Russell, Jerles E.—Engineering assistant, Allis-Chalmers Mfg. Co. (Mail) RR 1, Hubertus, Wis.

Santos, Alvaro S.—Manager of ranch and farm, Villavicencio, Colombia, S. A.

Sarcinelli, Salvatore — Research engineer, Centro Nazionale Meccanico Agricolo, Torino, Italy. (Mail) Via Thesauro, 2

Shaddock, Roland E. — Agricultural engineer, Dunbar-Kapple, Inc., Geneva, Ill.

Shute, George — Farm practice research analyst, International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill.

Smyth, Henry J. W.—Mechanical demonstrator in agricultural engineering branch, Agriculture Dept. Samaru, Zaria, Nigeria, Africa

Stansell, James R. Jr—Assistant agricultural engineer, Southwest Georgia Branch Experiment Station, Plains, Ga.

Swanson, Paul A. — Engineer, agricultural section, development div., Aluminum Co. of America, New Kensington, Pa.

Temple, Thomas D., III—2nd Lt., U.S. Army. (Mail) Scotland Neck, N. C.

Titcomb, Ralph M.—Graduate student in agricultural engineering, University of Maine, Orono, Me. (Mail) 16-G South Apt.

Twedt, Lynn O.—Engineer trainee, Ralston Purina Co., Iowa Falls, Iowa (Mail) Box 410

Ulfig, Charles C. Jr.—Junior engineer, J. I. Case Co. (Mail) 530 23rd St., Rock Island, Ill.

White, Francis G. — Technical director, Granite City Steel Co. (Mail) Bob White Farms, Girard, Ill.

Woodworth, Robert D.—Product designer, International Harvester Co. (Mail) 1107 5th Ave., Sterling, Ill.

Zutshi, Dwarka N. —Charge man, Central Tractor Organization Unit No. 3, Mission House Bina, C. P., India

Transfer of Membership Grade

Bornstein, Joseph—Civil engineer (SCS), USDA, 6816 Market St., Upper Darby, Pa. (Associate Member to Member)

Foss, Ray E.—Manager, northern div., Hilbe Engineering, Inc. (Mail) 3625 N. Fair Oaks Blvd., Carmichael, Calif. (Affiliate to Member)

Griffiths, L. R.—Resident engineer, Massey-Harris-Ferguson, Inc., Batavia, N. Y. (Affiliate to Associate Members)

Scarborough, Ernest N.—Senior test engineer, Thompson Products, Inc. (Mail) RR 3, Chardon, Ohio. (Associate Member to Member)

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NEWS SECTION

(Continued from page 42)

dealing with hay driers, trench silos, tobacco curing, and designing farm structures for crop processing.

St. Clair A. Knight, Jr., will preside at a rural electric program with contributions on public relations, 4-H electric activities, chick brooding and farm wiring materials.

Arvy Carnes will preside at a soil and water session dealing with watershed planning, water rights, pump drainage, and irrigation use of water.

In all, 65 speakers are listed in the program. Program committee chairmen include A. Carnes, R. P. Kay, C. M. Merkel, A. M. Pettis and John T. Phillips, previously noted as presiding at various sessions.

1955 ASEE Annual Meeting

THE 1955 annual meeting of the American Society for Engineering Education will be held at Pennsylvania State University, State College, June 20 to 24. These dates are the week following the 1955 annual meeting of ASAE at Urbana, Ill.

Ohio's A-E Curriculum Accredited

ACCORDING to information from G. W. McCuen, chairman, agricultural engi- that institution was recently notified that its professional curriculum in agricultural engineering department, Ohio State University, neering had been officially accredited by Engineers' Council for Professional Development, for the full five-year period.

This makes a total of 23 agricultural-engineering curriculums that now have ECPD creditation in the United States, two of which are curriculums of the University of California, at Davis and Los Angeles.

Program for Next I-I Section Meeting

THE subject "Cold Splining of Shafts" will be featured on the program of the next meeting of the ASAE Iowa-Illinois Section to be held at 6:00 p.m. on Friday, January 21, at the new American Legion Club, 1623-15th St., Moline, Ill. The paper will be presented by H. Pelphrey of the Michigan Tool Co. and will cover methods used and advantages gained.

A second feature on the program will be presented by W. V. Hukill, agricultural engineer, U.S. Department of Agriculture, stationed at Ames, Iowa, who will discuss the subject "Crop Drying and its Effects on the Farm Machinery Industry."

Chinese Agricultural Engineers Organize

THE agricultural engineers of Taiwan (Formosa) have organized the Chinese Society of Agricultural Engineers, which its founders report is to be an organization similar to ASAE. Over 300 eligible persons have applied for membership in the new organization, and its first meeting was held last month at Tainan Engineering College, Tainan, Taiwan, to elect officers and to adopt a constitution and by-laws. The organizers of the new society extend an invitation to Chinese students abroad, who major in or are interested in agricultural engineering, to make application for membership in the new society.

The individuals who have taken the initiative in getting this new organization of agricultural engineers started, are C. King, professor and head of the agricultural engineering department, National Taiwan University, Taipeh, Taiwan, and F. C. Ma, senior specialist of the Joint Commission on Rural Reconstruction of the same city. Inquiries concerning the CSAE may be addressed directly to these two individuals, or to K. S. Fang, 971 Bradford St., Pomona, Calif.

Exactly 10 years ago the first farm machinery society was organized by a handful of agricultural engineers in Chunking, then the war-time capital of China. Due to the widely scattered membership and the frequent change of location of its members, when the war ended, the organization had only a short existence.

Research Reports

THE federal government is conducting or sponsoring scientific and technical research at a current rate of $2 billion a year, mostly for defense purposes. By far the largest share represents applied research and development. This research generates a vast amount of non-confidential technical information that is available to businessmen and researchers who are interested in developing new production processes, in making technological improvements, and in avoiding duplication of research efforts. Even ideas for new products have been sparked by these reports.

Some 350 such reports are described each month in "U.S. Government Research Reports" (formerly "Bibliography of Technical Reports") which is available from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C., or any of the U.S. Department of Commerce field offices, at $6.00 a year.

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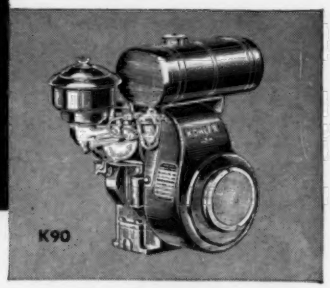

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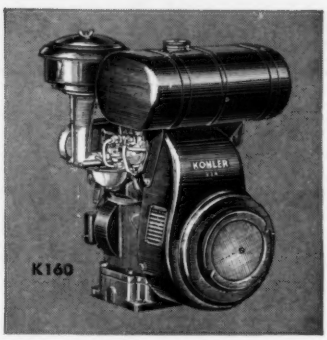
K160.....3.6 to 6.6 H.P.
K330.....7 to 12 H.P.
K660 (2 cylinder opposed) **12 to 26 H.P.**

Modern design, air-cooled Kohler Engines in sizes from 2.5 to 26 H.P. offer a power range to fit all applications requiring a reliable and economical power source.

Kohler branch offices are located in sixteen principal cities. Sales and service distributors, throughout the country, have parts available, are ready to assist you in selecting a Kohler Engine best suited for your requirements. Write for information.



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Today's most powerful Row Crop Tractor

Now more powerful than any other row crop tractor, the Super 88 has 49.81 max. h.p. on the drawbar.

It pulls bigger implements, handles heavier loads under tougher conditions and comes through with flying colors every time.

Tops in economy, too, the Super 88 set the record in recent nationally recognized tests. It has a new high in compression ratios—7.0:1—to squeeze extra power from every drop of fuel. Offers your choice of gasoline or diesel engine, whichever costs less to run.

"Hydra-lectric" control system raises and lowers implements and regulates depths at the touch of a lever. The Super 88 has the widest range of speeds in farming: five working speeds, plus one road speed, plus two reverse . . . and it has Oliver's famed Independently Controlled PTO.

Best news of all, the Super 88 makes all these advancements in tractor design available at a competitive market price.

The new 88 is one of the Oliver Super tractors—models 55, 66, 77, 88 and 99—developed to offer a standout value in each of five power classes.

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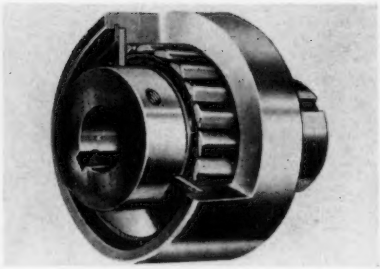
"FINEST IN FARM MACHINERY"

NEW PRODUCTS CATALOGS

Plain Bearing Cam Clutches

Morse Chain Co., 7601 Central Ave., Detroit 10, Mich., announces a new line of low-cost plain bearing cam clutches for indexing, overrunning and backstop application. Called the PB Series, these clutches are basically designed for operation in the lower speed and torque ranges. These self-contained units include long bronze bearing, hardened and ground steel inner and outer races, a full complement cam and energizing spring assembly, a snap ring, and a grease fitting for lubrication. The clutches are prelubricated at the factory.



The hardened ball-bearing steel cams feature a constant-pitch spacing design that avoids cam crowding and single-cam locking conditions. Shape of the cams is such that they cannot roll over under overload or peak torsional loads. A flat contour beyond the loads above normal capacity rating and prevents the cams from injuring the races or damaging the energizing springs.

New Twine-Tie Pickup Balers

J. I. Case Co., Racine, Wis., announces two new automatic twine-tie pickup balers No. 130, a one-man machine and designed for the family-size farm, and the No. 140,

for heavier duty operation, including custom work. These balers include a new needle design which provides greater clearance for incoming hay.

A large-diameter pickup cylinder permits clean lifting of hay. The pickup assembly can be quickly adjusted for height as the control is easily accessible from the tractor seat. These balers feature simplicity of construction and operation and have a minimum of working parts and an improved folding action in the baling chamber which saves power for slicing and pressing bales.

High-Strength Low-Alloy Steels

International Nickel Co., 67 Wall St., New York 5, N. Y., will send on request to interested readers a copy of its 16-page Bulletin A-61 describing a group of high-strength low-alloy steels, their characteristics, corrosion resistance, how they are formed and worked, and the design factors involved in their use. Applications in many fields are given and the economics of application are explained.

Rubber, Plastics Buying Guide

The General Tire & Rubber Co., Industrial Products Div., Wabash, Ind., will send on request to interested readers a copy of its 16-page buying guide (Catalog No. 786) devoted to molded and extruded rubber and extruded plastic. It is designed to help both technical and non-technical personnel and contains basic information covering specifications, terms, definitions, performance characteristics, tolerances, and tables of the properties available in the many types of common rubber and plastics compounds.

Five New Tractors

International Harvester Co., Chicago, Ill., announces five new Farmall tractors with new modern styling — Farmall Cub, 100, 200, 300 and 400. They replace the former Farmall Cub, Super A, Super C, Super H and Super M-TA. Each tractor includes the

fast-hitch introduced by the Company in 1953. The two larger sizes have the torque amplifier and independent power take-off, and they also have the new hydra-touch hydraulic system. The Farmall 200 is available with the new hydra-creeper drive permitting speeds as low as ¼ mile an hour for transplanting work.

Digs Up to 600 Bushels per Hour

It's WISCONSIN-POWERED

As much as ten tons of carrots or red beets per hour or a comparable amount of onions is handled by this Chickering Vegetable Harvester, built by Chickering Vegetable Equipment Co., Inc., Belding, Michigan. Power is provided by a V-type 4-cylinder Wisconsin Heavy-Duty Air-Cooled Engine.

Everywhere in the agricultural field Wisconsin Engines get the nod wherever equipment reputation is built by reliability. Builders know Wisconsin Engines stand up and deliver day after day on all assignments because of features like these: Tapered roller bearings at both ends of the crankshaft, absorb all combinations of thrusts, preventing shaft wear and "bell mouthing". Also, fool-proof air-cooling eliminates no less than 26 separate parts generally required for a liquid-cooled engine. These features, plus an easily-serviced *outside* magneto with impulse coupling and heavy-duty construction are responsible for dominance in the 3 to 36 hp. field.

Power TO FIT THE JOB

Power TO FIT THE MACHINE

Write for bulletin covering all 4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 36 hp.

MOST H.P. HOURS

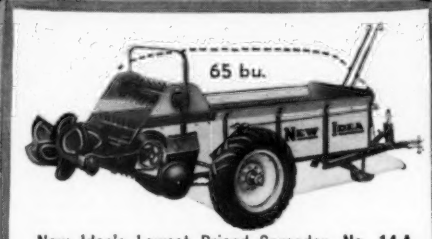
WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

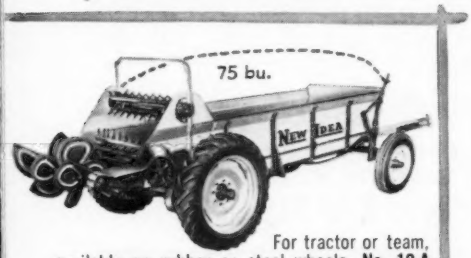
MILWAUKEE 46, WISCONSIN

A 8160-½-I

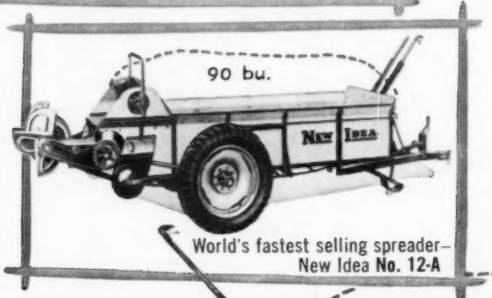
More farmers use NEW IDEA Manure Spreaders than any other make



New Idea's Lowest Priced Spreader—**No. 14-A**



For tractor or team, available on rubber or steel wheels—**No. 10-A**



World's fastest selling spreader—New Idea **No. 12-A**

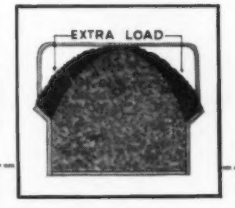
These four BEST SPREADER BUYS are the reasons why—

Every year more farmers make the comparison and buy NEW IDEA. Reasons why? NEW IDEA'S original widespread paddles can't be beat for wide, even spreading. NEW IDEA spreaders are convenient. They hitch or unhitch in seconds. Flared, non-choking bed gives extra capacity. Wide upper cylinder is placed ahead so top of load is removed first. This gives lower cylinder proper clearance to take out bottom of load.

New No. 15 P.T.O. Spreader

NEW IDEA'S biggest (120 bu. capacity) spreader cuts manure hauling to the quick. P.T.O. provides the constant power for wide, even spreading. It's built big and sturdy to do a real spreading job on the larger farms.

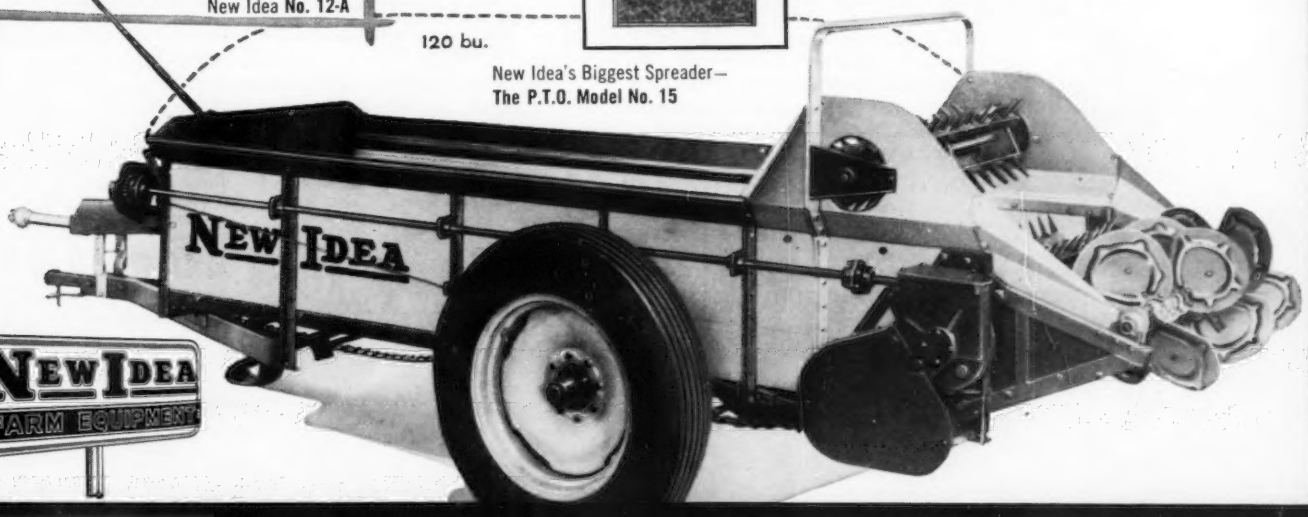
Heavy steel framework is lined with select wood. Large upper cylinder and heavy duty distributor take care of extra big loads. Has big tires which ride on tapered roller bearing wheels. It's quick on and off any tractor and operates easily over rough ground.



Flared, non-choking bed gives increased capacity.

120 bu.

New Idea's Biggest Spreader—
The P.T.O. Model No. 15



NEW IDEA
FARM EQUIPMENT COMPANY
Division AVCO Distributing Corporation
COLDWATER, OHIO, U. S. A.

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN—JUNE—O-181-628, 197-629. JULY—O-205-634, 209-636, 219-638, 222-639, 231-642. AUGUST—O-251-648, 244-649. SEPTEMBER—O-276-650, 262-651, 293-654. OCTOBER—O-326-656, 332-657, 327-659, 353-660. NOVEMBER—O-374-661. DECEMBER—O-403-662, 403-663, 417-664, 412-665.

POSITIONS WANTED — JUNE — W-199-137. JULY—W-177-138, 224-141. AUGUST—W-237-142, 252-143, 265-144. SEPTEMBER—W-246-147, 266-149, 294-150. OCTOBER—W-296-152, 330-153, 340-154, 365-155, 349-156. NOVEMBER—W-369-157, 372-159, 375-160. DECEMBER—W-400-161, 406-162, 371-163, 391-164, 409-165, 411-166.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEERS (2) assistant professor and professor rank, for teaching and research, one in farm machinery, and one in farm engines and tractors, in North Central land grant university. BS and MS or PhD in agricultural engineering or equivalent academic training or training and experience in industry. Experience desirable in teaching, public service research, or related commercial experience in farm power and machinery field. Usual personal qualifications for college teaching and research. Excellent opportunity in well-planned teaching and research programs already under way and supported by good facilities. Salary open. O-434-666

AGRICULTURAL ENGINEER, graduate research assistant in chemical weed and brush control in a midwestern land grant university, in active project established in close cooperation with departments of field crops, animal husbandry, horticulture, and forestry, and the U.S. Department of Agriculture. Appointee may carry up to 12 hours per semester in the Graduate School. With full under-graduate preparation he can complete the requirements for an MS deg in three semesters or possibly less. BS deg in agricultural engineering, or equivalent, with above average scholarship. Appointment effective at convenience of appointee, preferably before February 1. Salary $1500. O-437-667

PRODUCT SALES MANAGER, for product development, sales and service engineering, field sales and training, liaison with production department and research laboratory on new product developments, in irrigation field with large midwestern manufacturer of plastic pipe. BS deg in agricultural engineering, or equivalent, and engineering experience with a water district, preferably with sales interest. Travel to irrigated areas necessary. Excellent opportunity for advancement. Salary up to $500 per month with bonus participation and usual benefits. O-438-668

AGRICULTURAL ENGINEER for product design, development and field testing of tillage implements and related farm equipment, with major or full-line manufacturer, Midwest location. Age 25 or over. BS deg in agricultural or mechanical engineering or equivalent and two to three years or more of engineering experience. Farm background helpful but not required. Excellent opportunity for advancement. Retirement, hospitalization and insurance benefits. Salary open, depending on experience and qualifications. O-441-669

AGRICULTURAL ENGINEER for research and teaching in irrigation engineering and terracing with Southern land grant university. Age 30 to 45. MS deg in agricultural engineering, or equivalent. Experience in terracing or irrigation, with soil conservation, or in power and machinery plus one of the above. Must have pleasant disposition and be able to get along with fellow workers; see opportunities and organize work. Opportunities will depend on initiative and ability. Position on 12-mo basis with usual vacation period. To be filled soon as possible. Salary $5500-6500. O-442-670

AGRICULTURAL ENGINEER, instructor or assistant professor rank, for research (¾) and teaching (¼) in either rural electrification or power and machinery, in an eastern land grant university. Age under 45. BS or MS deg in agricultural engineering, or equivalent. Usual personal qualifications for teaching and research. Staff members may take up to 6 credits of course work per semester. Opening effective July 1. Salary $5000 or over. O-447-671

AGRICULTURAL ENGINEERS (4), graduate research assistants, any branch of agricultural engineering, in an eastern land grant university. Age, under 40. BS deg in agricultural engineering with above average scholarship, and interest in graduate study. Research or teaching half time. Up to 10 credits per semester graduate study. Should be able to complete requirements for the MS deg in three semesters. Salary $1572. O-447-672

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design, development, sales, service, or management in power and machinery field with manufacturer, consultant, or trade association in Midwest. Limited travel. Married. Age 28. No disability. BS and MS deg in agricultural engineering, 1951 (mechanical option), University of Missouri. Experience as tooling engineer, liaison engineer, and project engineer. War enlisted service in Navy over 2 yr, S 1/C, radar operator. Available on 45 days notice. Salary open. W-424-167

AGRICULTURAL ENGINEER for sales, service, or research work in rural electrification in the Midwest. Married, no children. Age 27. No disability. BS deg in agricultural engineering, Purdue University, 1949. Three years with Rural Electrification Administration in power use program traveling Iowa, Wisconsin, and Illinois. Two years enlisted service U.S. Marine Corps; now 2d Lt., Army National Guard. One year managerial trainee in retail lumber and building materials. Farm background. Available on short notice. Salary open. W-429-168

MECHANICAL ENGINEER for product testing in the farm implement industry. Age 35. Married. Vision corrected by glasses. BS deg in mechanical engineering, Michigan College of Mining and Technology, 1953. Farm background. Military service 2 years. Laboratory and field experience in preparing test procedures and writing reports on farm implement tests, 1½ yr. Will travel. Salary $450 per mo. W-427-169

AGRICULTURAL ENGINEER for test, design, development, research, or writing in power and machinery field in industry or public service. Slight preference for western U.S.A. Prefer some travel. Single. Age 29. No disability. BS deg in agricultural engineering, January, 1954, University of Nebraska. Farm background, including 2 yr full time operating experience before entering college. Part-time work on experiment station farm 2 yr while in college. Project engineering 1 yr since graduation, with farm equipment manufacturer. War noncommissioned service in Army, 3 yr. Available Feb. 15. Salary $425 per mo. W-431-170

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for Maintenance ENGINEERS

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The horsepower transmitted depends on: belt speed; sheave sizes; belt length; belt cross section; as well as careful installation.

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FREE COPY! *Handy Tips on V-belts and V-drives*

See your D-A distributor or write Dept. AE-1 for catalog that includes conversion tables, engineering data, latest Rubber Manufacturers Association horsepower ratings, drive selections and helpful Do's and Don'ts of V-belt operation.

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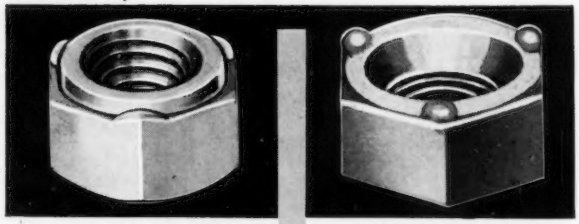

Gripco Pilot-Projection Weld Nut
Circular pilot designed for quick, easy positioning of nut over bolt hole for instant resistant welding. No jigs, no fumbling, no waste of time. Furnished with or without famous Gripco locking feature.

Gripco Countersunk Weld Nut
Eliminate time-wasting retapping of nuts after welding. Exclusive countersunk nut bottom does away with fouling of nut threads by weld spatter. Available with or without Gripco locking feature.

Gripco weld nuts are proud members of the Gripco Lock Nut family that has for 50 years provided positive holding action for quicker fastening application at less cost. Also included in the Gripco line: Gripco Lock Nuts, New Gripco "Clinch" Nuts, Gripco Hi-Nuts in all standard sizes. For any fastening problem, look to Gripco first. Write for samples and full details.

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HARRY E. HUMPHREYS, Jr.
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If you do not have the Payroll Savings Plan, or if you have the Plan and your employee participation is less than 60%, here's all you have to do to help your employees, your company and the country:

Write today to Savings Bond Division, U. S. Treasury Department, Washington, D. C. Tell them you want to join the United States Rubber Company and the 45,000 other companies that are making an important contribution to national security and a sounder dollar.

Your State Director, U. S. Savings Bond Division, will contact you promptly. He will explain the simple procedure of installing the Plan and will show you how to conduct a simple, person-to-person canvass that will put a Payroll Savings Application Blank in the hands of every man and woman in your plant and offices.

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AGRICULTURAL ENGINEERING

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Over 400 interchangeable orifice tips to fit any TeeJet Spray Nozzle . . . give you a choice to meet the need of any crop and any type of spraying. Tip types include flat spray, hollow cone, full cone, and straight stream. Try TeeJet Spray Nozzles . . . proved best in the field . . . guaranteed for exact performance.

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Call on NEW DEPARTURE

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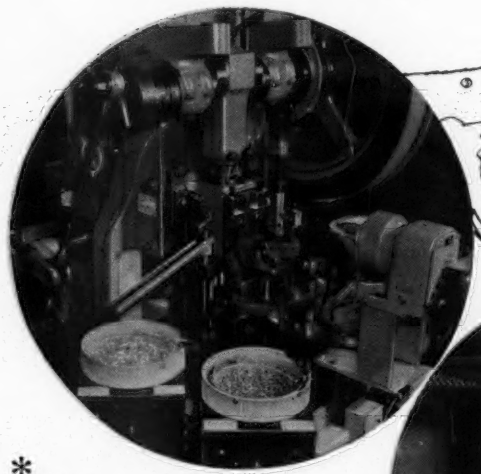

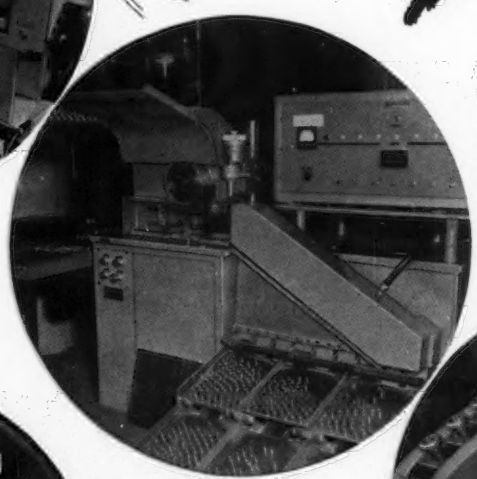

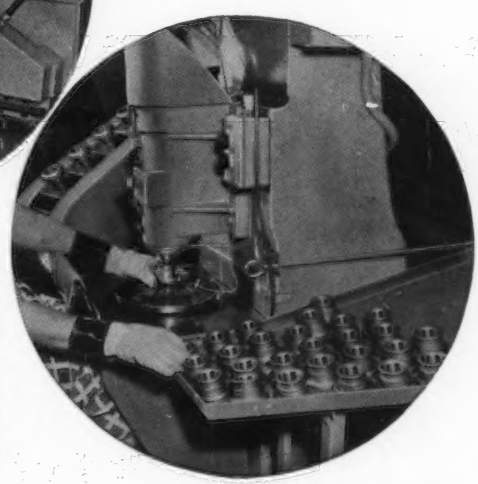

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* **DELIVERY!**—Electronics work at New Departure! Bearing races are speedily sorted into six dimensional classifications by this machine. Volume is up because New Departure invested in this modern equipment.

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BALL BEARINGS

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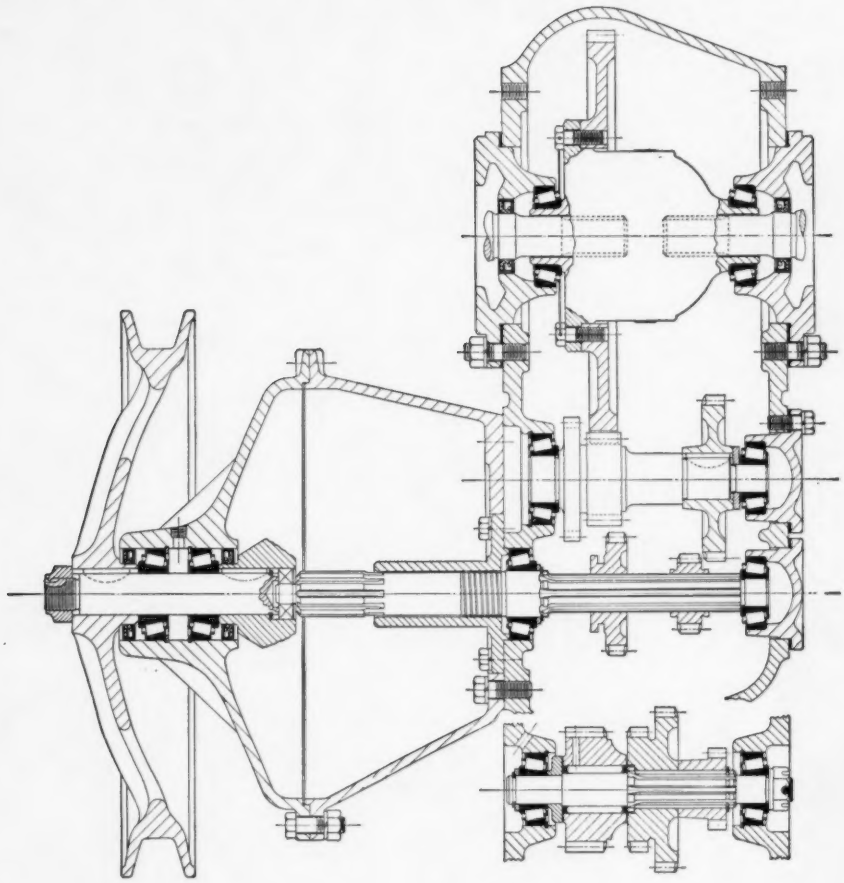
How John Deere Designs Smooth Shifting Into Its Combine Transmission



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